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BARS CURVE IN ROMANIAN ECONOMY

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Abstract

The paper is consacrated to the binomial “public budget-global output” from the BARS curve perspective. The first section characterizes the main conceptual premises of this approach. The second is devoted to empirical analysis, using the statistical data (1990-2013) for Romania, an European emergent economy: three cointegrating regressions (fully modified least squares, canonical cointegrating regression and dynamic least squares) and three algorithms based on instrumental variables (two-stage least squares, generalized method of moments, and limited information maximum likelihood) are used. Some conclusions are presented.

Keywords: public budget, global output, BARS curve

JEL Classification: C32, E62, H60.

I. Conceptual Framework

The notable increase during the last few centuries - in the public expenditure - of the most advanced or developing countries - has motivated research interest in the field of correlation between these expenditures and economic growth. This mainstream research was significantly stimulated by the pioneering works of Barro (1990, 1991), Armeiy (1995), Rahn (1996), and Scully (1989, 1995, 1998). This explains why the economic postulate relating to the interdependence between public expenditure and global output is widely acknowledged in the literature as the “BARS Curve”.

This postulate assumes the existence of an inverted U-shaped relationship between the government size and the dynamics of the gross domestic product. Besides the above mentioned seminal contributions, several other researchers examined this postulate from different angles: Tanzi and Schuknecht (1996, 2000), Chao and Grubel (1998), Gwartney et al. (1998), Tanzi (2005), Afonso et al. (2008), Altunc and Aydin (2013), Magazzino and Forte (2010), Di Liddo et al. (2013).

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The “BARS Curve results from a very complex and protracted interaction between the positive effects of public goods and services, on the one hand, and the decreasing marginal returns law, which also operate in this field, on the other.

1. Rahn (1996) compares the advantages of public spending (“the public goods and services essential for proper functioning of markets--personal property rights, police forces to protect the rights of people and property, an effective judicial system, national defense against foreign predations, etc.”, p. 9-10) relative to the negative effects induced by both financial sources (“taxation, borrowing, or printing money”, p. 8) and possible destinations (especially “transfer payments”, p. 9). His concluding statement goes thus: “Most studies of the relationship between economic growth and government spending have found negative correlations for most countries for most time periods. On the other hand, we also know that too little government is not conducive to economic growth...(p.2-3)”.

2. The opposing forces involved in this issue are characterized as follows by Chao and Grubel (1998): “First, there is the law of diminishing returns to additional government spending... Second, the withdrawal of resources from the private sector initially occurs at the cost of projects with low returns. But the more private spending is reduced, the higher the yield being sacrificed. So economic growth slows or turns down because of decreasing private sector output at growing marginal rates. Third, to raise revenue with which to finance government spending, governments have to impose taxes. Such taxation reduces the private sector's incentives to work, save, invest, and take risks. This, in turn, lowers economic growth. Finally, some of the spending programs can have additional and somewhat different disincentive effects if they lower the risk of economic life. (p. 56)”. Gwartney et al. (1998) observed as follows: “Government provision of both (a) a legal and physical infrastructure for the operation of a market economy and (b) a limited set of public goods can provide a framework conducive for economic growth. However, as governments move beyond these core functions, they will adversely affect economic growth because of (a) the disincentive effects of higher taxes, (b) diminishing returns as governments undertake activities for which they are ill-suited, and (c) an interference with the wealth creation process, because governments are not as good as markets at adjusting to changing circumstances and finding innovative new ways of increasing the value of resources. (p.V)”

3. Non-linearity of the relationship between “government size and economic growth” is also explained as a cumulative effect of the interaction between market failures (existence of public good, externalities, natural monopoly and asymmetric information) and state failures (political transaction costs, bureaucracy as a monopoly, electoral cyclicality and other political sources of instability). Consequently, “if the market failures justify the increase of the scale of government activity, the State failures can explain why this evolution can be a burden on economic prosperity.” (Facchini and Melki, 2011, p. 8).

4. Generally, such a parabola with maximum is accepted as a pertinent approximation of the real interdependence between budget expenditure and economic growth. The agreement regarding its concrete parameters (especially extremum point of the respective curve) is, however, much less.

The empirical examinations cover many cases (United States and other members OECD, emergent European economies, developing countries), either as an individual analysis or as a cross-section analysis. They are favored by more and more diversified statistical sources and, also, by the advances of econometric and computational techniques. Based on 14

studies that estimated the non-linear relationship between government activity and its performance, Facchini and Melki (2011) conclude thus: “the optimal size of government can vary from around 20% to 40% of GDP. The bulk of these studies are on the United-States and they tend to converge towards a 20% ratio...In other countries, the studies found most often higher optimal sizes such as 27% for Canada..., 36-42% for 8 European countries and especially 43% for France..., 35% for 23 OECD countries...or 40% in low-income countries. (p. 6-7)”

II. Empirical Analysis

1. As the starting point of a possible econometric quantifying the BARS curve, each of the following basic indicators and elementary relationships will be involved:

$$BE=TAXT+DB \quad (1)$$

BE – Total public budget expenditures, current prices;

TAXT – Collected taxes;

DB – Non-taxes budget revenues (including financed balance);

$$cbe=BE/GDP \quad (2)$$

cbe – Ratio to GDP of the public budget expenditures;

GDP – Gross domestic product, current prices.

The following is the simplest formalization of the BARS curve:

$$IGB=\beta_1*cbe+\beta_2*cbe^2+\beta_3*IOT \quad (3), \text{ where}$$

IGB – Measure of economic growth;

IOT – Dynamics of non-budget factors which influence the economic growth.

It seems reasonable to admit that, for $IOT=0$), the BARS curve passes through the origin of coordinates. Consequently, relationship (3) has also been tested for the intercept=0. The parameters β_1 , β_2 , and β_3 quantify the impact of the corresponding variables on economic growth. In this extremely simplified form, the BARS curve assumes that $\beta_1>0$ and $\beta_2<0$. The algebraic sign of β_3 cannot be defined univocally; it depends on business cycle phases and, generally, on many contextual circumstances (domestic or international). From the first derivative of IGB relationship, the optimal level of cbe (denoted as oe) is equal to $0.5*\beta_1/(-\beta_2)$.

2. To econometrically identify a possible BARS curve in an emergent economy, we shall refer to the 2012 Version of the Romanian macromodel, as described in Dobrescu (2013a, 2013b). This version classifies the general consolidated budget (GCB) expenditures into nine groups:

$$BE=GW+GSOBET+GBS+TRE+SA1OTR+KEEUP+GIE+RL+EUC \quad (4), \text{ where}$$

GW - GCB expenditures for labor cost;

GSOBET - GCB purchasing of goods, services, and other temporary expenditures;

GBS – GCB subsidies;

- TRE – GCB expenditures for pensions;
- SA1OTR – GCB social expenditures (including unemployment) and other transfers;
- KEEUP - GCB capital expenditures and EU projects;
- GIE - GCB interest payments;
- RL - GCB repayments and loans;
- EUC – National contribution to common budget of European Union.

Undoubtedly, each of the above mentioned budgetary items has a specific influence on the global output of economy. With the statistical data now available, such a dis-aggregated analysis is not yet possible. This explains why the BARS curve has to be examined using only the total general consolidated budget expenditures. Appendix A1 contains main involved indicators for Romania for the period 1990-2013; the data shown for 2012-2013 years are provisional.

3. Reverting to relationship (3), some remarks are warranted.

3.1. In our econometric application, the economic growth (IGB variable) is expressed by the annual index of real gross domestic product (IGDPc):

$$IGDPc = \frac{GDP}{(GDP(-1) * PGDP)} \quad (5)$$

PGDP - the annual GDP deflator.

3.2. It is not at all easy to choose a relevant statistical substitute for the so-called IOT variable, which measures the dynamics of non-budget factors that impact economic growth.

Finally, from a large set of potential concurrent indicators, the annual index (in real terms) of the volume of the gross fixed capital formation (IGFCFc) is retained:

$$IGFCFc = \frac{GFCF}{(GFCF(-1) * PK)} \quad (6)$$

GFCF - gross fixed capital formation, current prices;

PK – GFCF deflator (previous year=1)

Taking into account the inertia of the gross fixed capital formation, this variable was included in the specification as a geometric moving average index for two successive years (aICF):

$$aICF = (IGFCFc * IGFCFc(-1))^{0.5} \quad (7)$$

The interference of this index with cbe (also included in the econometric specification) was presumed to be negligible, because the share of public investments in the total accumulation was relatively modest during the given interval.

3.3. The relationship (3) was tested for intercept=0.

4. The following econometric specification was retained for estimations:

$$IGDPc = \beta_1 * cbe + \beta_2 * cbe^2 + \beta_3 * aICF \quad (3a)$$

The Augmented Dickey-Fuller (ADF) shows, for constant term, that cbe, cbe², and IGDPc are I(0). Similar results (although at a lower statistical confidence level) are generated by the Phillips-Perron (PP) technique. In the case of aICF, I(0) hypothesis is accepted

according to PP test, but not for the ADF one; as expected, both ADF and PP admit this series as I(1).

The Johansen procedure – either trace or max-eigenvalue test - indicates two cointegrating equations at 0.05 level.

5. Consequently, specification (3a) was estimated by three cointegrating regressions: the fully modified least squares (FMOLS), the canonical cointegrating regression (CCR), and the dynamic least squares (DOLS). The corresponding equations are denoted as EqB1, EqB2, and EqB3.

5.1. The estimators and coefficients of determination were synthesized in Table no. 1.

Table no. 1: Estimation output for $IGDP_c=f(cbe, cbe^2, aICF)$ using the cointegrating regressions

Variable	Parameter symbol	EqB1-FMOLS	EqB2-CCR	EqB3-DOLS
cbe	β_1	4.610849	4.642162	4.846102
cbe ²	β_2	-7.23347	-7.29228	-8.4111
aICF	β_3	0.285064	0.281593	0.340983
R-squared		0.5634	0.563266	0.726817
Adj. R-squared		0.514889	0.51474	0.635756

The results obtained by the first two algorithms are almost similar, whereas those obtained by the last method are somewhat different. The last method compensates the more accentuated negative coefficient for cbe² by a greater weight of investment processes in economic growth.

The discrepancy registered between R² and adj-R², in the case of DOLS procedure, derives especially from the lower number of degrees of freedom involved in this technique.

5.2. Cointegrating tests are encouraging (Table no. 2).

Table no. 2: Cointegration tests for equation $IGDP_c=f(cbe, cbe^2, aICF)$

	EqB1-FMOLS		EqB2-CCR		EqB3-DOLS	
	Value	Prob.	Value	Prob.	Value	Prob.
<i>Park Added Variables</i> - Null hyp.: series are cointegrated						
Chi-square	3.843626	0.2789	1.804311	0.614	2.500106	0.4753
<i>Engle-Granger</i> - Null hyp.: series are not cointegrated						
Engle-Granger tau-statistic	-4.76527	0.0008	-4.76527	0.0008	-4.76527	0.0008
Engle-Granger z-statistic	-22.5098	0.0007	-22.5098	0.0007	-22.5098	0.0007
<i>Phillips-Ouliaris</i> - Null hyp.: series are not cointegrated						
Phillips-Ouliaris tau-statistic	-4.97979	0.0005	-4.97979	0.0005	-4.97979	0.0005
Phillips-Ouliaris z-statistic	-19.7451	0.0028	-19.7451	0.0028	-19.7451	0.0028

5.3. The residuals of equations EqB1-FMOLS, EqB2-CCR, and EqB3-DOLS (denoted resB1, resB2, and resB3) were tested for

- normality (based on Jarque-Bera statistic),
- unit root (ADF and PP), and
- serial correlation (BDS for both normal and bootstrap probabilities, in three distance options – fraction of pairs, standard deviations, and fraction of range - and five dimensions, namely 2, 3, 4, 5, and 6).

All these tests (see Appendix A2.1) validate the econometric specification adopted above.

5.4. Table no. 2 shows that, in all determinations, the estimators of EqB1, EqB2, and EqB3 attest the presence of a BARS curve in the statistical series examined. The optimal levels of cbe are: 0.318716 for oe1, 0.318293 for oe2, and 0.288078 for oe3.

6. Nevertheless, a problem arises from the relatively high correlation coefficients among cbe, cbe², and aICF, which means that the effects of collinearity could be significant. The variance inflation factors are shown in Table no. 3.

Table no. 3: Variance inflation factors of cointegrating regressions for $IGDP_c=f(cbe, cbe^2, aICF)$

Variable	EqB1-FMOLS		EqB2-CCR		EqB3-DOLS	
	Coefficient Variance	Uncentered VIF	Coefficient Variance	Uncentered VIF	Coefficient Variance	Uncentered VIF
cbe	0.49122	1741.749	0.567504	2000.723	0.80292	2118.536
cbe ²	2.127911	926.8272	2.119953	923.3612	3.777119	1232.668
aICF	0.005186	174.8329	0.007647	257.8074	0.008355	208.973

The possible consequences of collinearity cannot, therefore, be ignored, especially in such cases as our application, where the main target is to approximate the separate contributions of causal factors to the variation of resultant indicator.

7. To attenuate this possible weakness, relationship (3a) was estimated by the three following algorithms, using instrumental variables:

- two-stage least squares (TSLS),
- generalized method of moments (GMM), and
- limited information maximum likelihood (LIML).

The corresponding equations are denoted as EqB4, EqB5, and EqB6, and the computed coefficients described in Table no. 4.

Table no. 4: Estimated output for $IGDP_c=f(cbe, cbe^2, aICF)$, using instrumental variables

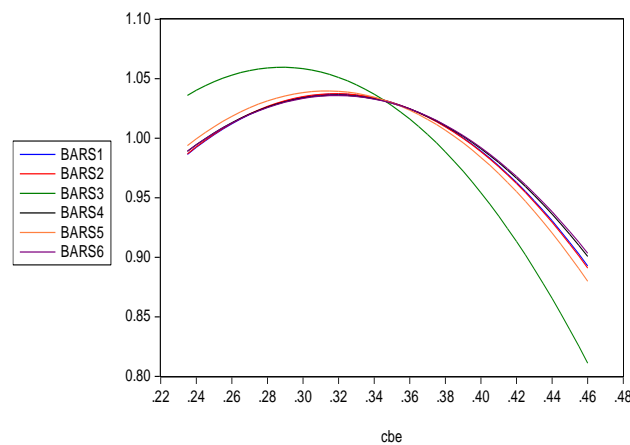
Variable	Parameter symbol	EqB4-TSLS	EqB5-GMM	EqB6-LIML
cbe	β_1	4.312855	4.671655	4.244986
cbe^2	β_2	-6.77026	-7.45111	-6.65525
aICF	β_3	0.329417	0.289913	0.338464
R-squared		0.66137	0.664844	0.659044
Adj. R-squared		0.625725	0.629564	0.623154

The estimations with instrumental variables modified the coefficients of cbe and cbe^2 more significantly than the cointegrating regressions did. As a consequence, the optimal level of cbe became 0.318515 in TSLS, 0.313487 in GMM, and 0.31892 in LIML. These econometric results were also subjected to residuals tests for normality, unit root, and serial correlation (Appendix A2.2).

III. Conclusion

The econometric analysis confirms, therefore, the presence of the BARS curve in the statistical series of the Romanian economy. In order to make this result more visible, the above determinations (EqB1-EqB6) were simulated for changing cbe from 0.235 to 0.46, under constant $aICF=1.060584$ (mean of used sample). In GraphBARS there are plotted the obtained values of $IGDP_c$ (noted BARS with suffix of corresponding equation).

GraphBARS



The experience of an emergent economy as Romania attests therefore the consistency of the Barro-Armeey-Rahn-Scully (BARS) curve as parabolas with maximum. This conceptual construct proved to provide a relevant framework for interpreting the relationships of public expenditures with such essential macroeconomic indicator as global output.

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Appendix A1: Main Economic Indicators

	BE	BR	cbe	cdb	GDP	GFCF
Year	General consolidated budget expenditures, bill. RON	General consolidated budget revenues, bill. RON	Ratio to GDP of the public budget expenditures	Ratio to GDP of the non-fiscal difference of the public budget expenditures	Gross domestic product, current prices, bill. RON	Gross fixed capital formation, current prices, bill. RON
1990	0.0327	0.0325	0.381163	0.082177	0.08579	0.01698
1991	0.0841	0.0904	0.381596	0.093108	0.22039	0.0317
1992	0.2495	0.2217	0.413819	0.161547	0.60292	0.11568
1993	0.6771	0.67	0.337947	0.066506	2.00357	0.35837
1994	1.663	1.5663	0.334116	0.072921	4.97732	1.00957
1995	2.5513	2.3662	0.333551	0.104407	7.6489	1.6105
1996	3.7608	3.3423	0.330353	0.113886	11.3842	2.5442
1997	8.7112	7.8423	0.341217	0.106025	25.5298	5.4313
1998	13.4417	12.1375	0.362749	0.100272	37.0551	6.792
1999	19.6492	18.742	0.356019	0.094466	55.1914	9.7076
2000	29.2181	25.991	0.360786	0.098848	80.9846	15.2452
2001	40.1955	36.5725	0.340796	0.088251	117.9458	24.1714
2002	51.5496	48.1785	0.339104	0.088983	152.017	32.3665
2003	63.4862	60.258	0.321567	0.072194	197.4276	42.4966

	BE	BR	cbe	cdb	GDP	GFCF
Year	General consolidated budget expenditures, bill. RON	General consolidated budget revenues, bill. RON	Ratio to GDP of the public budget expenditures	Ratio to GDP of the non-fiscal difference of the public budget expenditures	Gross domestic product, current prices, bill. RON	Gross fixed capital formation, current prices, bill. RON
2004	80.1064	76.9561	0.323835	0.073947	247.368	53.8503
2005	92.5412	90.6796	0.320262	0.067483	288.9546	68.5266
2006	115.751	111.3882	0.33585	0.079146	344.6505	88.272
2007	147.1411	134.1734	0.353699	0.095602	416.0068	125.6453
2008	190.3399	165.5471	0.369807	0.115141	514.7	164.2794
2009	193.6792	157.244	0.386478	0.139844	501.1394	122.4419
2010	202.2821	168.6746	0.387098	0.158449	522.5611	125.2266
2011	205.8185	181.9199	0.369712	0.111512	556.7	145.2
2012	207.9222	193.1482	0.35391	0.096647	587.5	154.3
2013	216.1683	200.3743	0.345206	0.085035	626.2	144.5

Appendix A1 (Continued)

	GVA	IGDPC	IGFCFc	PGDP	PK	T	TAXT
Year	Total gross value added, current prices, bill. RON	Annual index of the gross domestic product at constant prices (previous year=1)	Annual index of the gross fixed capital formation at constant prices (previous year=1)	Annual GDP deflator (previous year=1)	Annual GFCF deflator (previous year=1)	Time	Total collected taxes (DTP+DTW+SSC+NIT), bill. RON
1990	0.07881	NA	NA	1.136111	1.102597	NA	0.02565
1991	0.20661	0.870731	0.683746	2.950335	2.730405	1	0.06358
1992	0.59152	0.912337	1.109779	2.998558	3.288232	2	0.1521
1993	1.85792	1.015276	1.083074	3.273112	2.860324	3	0.54385
1994	4.59547	1.03932	1.20716	2.390242	2.333672	4	1.30005
1995	7.2093	1.136042	1.116247	1.352724	1.429105	5	1.7527
1996	10.7589	1.032139	1.057401	1.442	1.494	6	2.4643
1997	23.6912	0.951449	1.003185	2.357	2.128	7	6.0044

Year	GVA Total gross value added, current prices, bill. RON	IGDPC Annual index of the gross domestic product at constant prices (previous year=1)	IGFCFC Annual index of the gross fixed capital formation at constant prices (previous year=1)	PGDP Annual GDP deflator (previous year=1)	PK Annual GFCF deflator (previous year=1)	T Time	TAXT Total collected taxes (DTP+DTW+SSC+NIT), bill. RON
1998	33.1717	0.978722	0.952421	1.483	1.313	8	9.7261
1999	49.144	0.996282	0.982992	1.495	1.454	9	14.4355
2000	72.7364	1.0241	1.062652	1.43281	1.47785	10	21.2129
2001	106.12	1.056785	1.098964	1.37814	1.44273	11	29.7867
2002	136.9223	1.050768	1.089289	1.2266	1.22928	12	38.0226
2003	175.6409	1.052367	1.087589	1.234095	1.20724	13	49.2331
2004	220.9313	1.084903	1.110199	1.154901	1.141387	14	61.8143
2005	255.2327	1.041536	1.153342	1.121532	1.103349	15	73.0417
2006	304.2698	1.078748	1.198708	1.10568	1.074609	16	88.4732
2007	368.3563	1.063172	1.3031	1.135319	1.092309	17	107.3699
2008	458.5355	1.073489	1.155543	1.15254	1.13149	18	131.0767
2009	450.9791	0.934408	0.719143	1.042	1.03641	19	123.5978
2010	466.397	0.986515	0.979114	1.057	1.04456	20	119.4826
2011	487.3268	1.023372	1.113788	1.041	1.04104	21	143.74
2012	512.1	1.00699	1.027729	1.048	1.034	22	151.1421
2013	554.2	1.02291	0.908861	1.042	1.030397	23	162.9192

Appendix A2: Statistical tests

A2.1 Tests of residuals for cointegrating regressions IGDPC=f(cbe, cbe², aICF)

Tests	resB1		resB2		resB3	
<i>Normality</i>	JB Stat.	Prob.	JB Stat.	Prob.	JB Stat.	Prob.
	0.576743	0.749483	0.604152	0.739282	0.918025	0.631907
<i>Unit root for I(0)</i>						
Aug. Dickey-Fuller	t-Stat.	Prob.	t-Stat.	Prob.	t-Stat.	Prob.
	-4.773675	0.0001	-4.77636	0.0001	-4.18433	0.0003
Phillips-Perron	Adj. t-Stat.	Prob.	Adj. t-Stat.	Prob.	Adj. t-Stat.	Prob.
	-5.311322	0	-5.30942	0	-4.43304	0.0001

Tests	resB1		resB2		resB3	
<i>BDS</i>	Normal Prob.	Boot. Prob.	Normal Prob.	Boot. Prob.	Normal Prob.	Boot. Prob.
Fraction of pairs						
Dimension						
2	0.6389	0.8886	0.6389	0.901	0.2732	0.5906
3	0.4235	0.389	0.4235	0.3854	0.8959	0.8542
4	0.0522	0.1104	0.0522	0.1058	0.0517	0.3054
5	0.1197	0.1508	0.1197	0.1494	0.5097	0.938
6	0.0498	0.0802	0.0498	0.0888	0.7722	0.828
St. deviations						
Dimension						
2	0.0445	0.3865	0.0445	0.3906	0.9305	0.7986
3	0.6684	0.9179	0.6684	0.9248	0.5516	0.5492
4	0.9061	0.67	0.9061	0.6658	0.7755	0.6148
5	0.8606	0.552	0.8606	0.5466	0.1864	0.3164
6	0.2188	0.7866	0.2188	0.7766	0.3891	0.8154
Fraction of range						
Dimension						
2	0.6157	0.8986	0.6157	0.888	0	0.36
3	0.4142	0.962	0.4142	0.9416	0	0.2082
4	0.0255	0.7362	0.0255	0.722	0.0006	0.7146
5	0	0.8604	0	0.8744	0.7782	0.8134
6	0.275	0.803	0.275	0.7918	0.0502	0.6314

A2.2 Tests of residuals for equations with instrumental variables
 $IGDP_c = f(cbe, cbe^2, aICF)$

Tests	resB4		resB5		resB6	
<i>Normality</i>	JB Stat.	Prob.	JB Stat.	Prob.	JB Stat.	Prob.
	0.492582	0.781695	0.803178	0.669256	0.437464	0.803537
<i>Unit root for I(0)</i>						
Aug. Dickey-Fuller	t-Stat.	Prob.	t-Stat.	Prob.	t-Stat.	Prob.
	-4.74544	0.0001	-4.82378	0	-4.72935	0.0001

Tests	resB4		resB5		resB6	
Phillips-Perron	Adj. t-Stat.	Prob.	Adj. t-Stat.	Prob.	Adj. t-Stat.	Prob.
	-5.55146	0	-5.40693	0	-5.55953	0
<i>BDS</i>	Normal Prob.	Boot. Prob.	Normal Prob.	Boot. Prob.	Normal Prob.	Boot. Prob.
Fraction of pairs						
Dimension						
2	0.0873	0.2584	0.1069	0.2668	0.0818	0.247
3	0.814	0.9154	0.8791	0.6946	0.7043	0.983
4	0.8258	0.6122	0.4556	0.3942	0.9789	0.7654
5	0.3659	0.7096	0.8635	0.8174	0.1718	0.4534
6	0.4779	0.8276	0.8705	0.5636	0.2992	0.6222
St. deviations						
Dimension						
2	0	0.0332	0.0522	0.3704	0	0.0214
3	0.0202	0.3044	0.2533	0.7347	0.0136	0.252
4	0.2494	0.7772	0.5065	0.9899	0.2025	0.7072
5	0.2986	0.9134	0.6318	0.7857	0.2355	0.7912
6	0.0426	0.3922	0.1863	0.7007	0.0578	0.3928
Fraction of range						
Dimension						
2	0.4989	0.9466	0.6309	0.8922	0.4989	0.9856
3	0	0.4982	0.439	0.9426	0	0.5064
4	0	0.4398	0.2628	0.9566	0	0.4436
5	0.0021	0.705	0	0.727	0.0021	0.7018
6	0	0.6252	0	0.908	0	0.6056