Statistical Analysis of the Government Expenditure for Greece: January 2008- September 2015

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Abstract

The main purpose of the present study is to develop a statistical analysis of the government expenditure for Greece during the period January 2008- September 2015. The source of the official data is the Greece Organization for Economic Co-operation and Development. The Kolmogorov's Central Limit Theorem, "fair game" concept in the sense of Stein-Vorobiev, Kolmogorov- Smirnov- Lilliefors test and Shapiro- Wilk test are applied. The government expenditure is estimated based on current price or as a percentage of GDP. Some results of the present study include: The official data of quarterly government expenditure for Greece during the period January 2008-September 2015 contradicts the CLT at the confidence level 95%. The official data of quarterly government expenditure expressed as a fraction of GDP for Greece during the period January 2008-September 2015 contradicts CLT at the confidence level 95%. The government expenditure process in Greece during the period January 2008-September 2015 is an unfair game at the confidence level 95%. The government expenditure as a fraction of GDP in Greece during the period January 2008-September 2015 is an unfair game at the confidence level 95%. The official data of quarterly GDP for Greece during the specified period contradicts CLT at the confidence level 95%. The quarterly GDP in Greece during the specified period is a fair game at the confidence level 95%.

Keywords: government expenditure, GDP, CLT, fair game, OECD, Greece.

Abbreviations

CLT- Central Limit Theorem

GDP- Gross Domestic Product

KSL- Kolmogorov-Smirnov-Lilliefors

SW- Shapiro-Wilk

OECD- Organisation for Economic Co-operation and Development

Introduction

The main purpose of this study is to develop a statistical analysis of the quarterly government expenditure for Greece during the period January 2008 – September 2015. The source of the official data is the Organization for Economic Co-operation and Development (OECD).

Definition 1

Government expenditure for a given country during a specified period of time is the market value of government purchases of goods and services.

Government expenditure includes government purchases of goods and services produced domestically or abroad. For the purpose of GDP accounts, government expenditure excludes transfer payments (for example, Social Security payments to retirees) and also excludes interest paid on government debt. These categories are omitted because they represent payments to other agents in the economy, who will use those payments to buy goods and services. To avoid double-counting, these government payments to other agents are not counted as government expenditure on goods and services.

According to the Keynesian Theory, increased government expenditure raises aggregate demand and increases consumption, which leads to increase production and faster recovery from recessions. Classical economists, on the other hand, believe that increased government expenditure exacerbates an economic contraction by shifting resources from the private sector, which they consider productive, to the public sector, which they consider unproductive, see Blanchard (2011), Mankiw (2011).

Government expenditure is a component of the GDP formula:

GDP= C+I+G+X-M ,

where C denotes consumption, I denotes investments, G denotes government expenditure, X denotes exports, and M denotes imports. GDP represents gross domestic product.

GDP is the market value of all officially recognized final goods and services produced within a country in a given period of time (quarterly GDP versus annual GDP), Blanchard (2011) and Mankiw (2011).

GDP can be determined in three ways, all of which should, in principle, give the same result:

-Production Approach

-Expenditure Approach

-Income Approach

In the present study it is applied the Expenditure Approach.

The government expenditure for Greece is expressed in Euro or as a fraction of GDP, called GDP share.

The rest of the paper is organized as follows:

Section 2 contains the methodology of the research

Section 3 provides the dynamics of quarterly government expenditure

Section 4 presents the investigation of fair game hypothesis for government expenditure

Section 5 provides the dynamics of quarterly GDP process

Section 6 concludes the paper

Methodology

Theoretical approach of the present study contains CLT, Martingale Theory and Hypothesis Testing, especially for fair game hypothesis in the sense of Stein – Vorobiev.

The GDP formula (or National Income Accounting Identity) confirms that the market value of domestic production is equal to total expenditure of domestic economic agents (C+I+G), plus the expenditure of foreign agents on exports (X) minus the value of domestic expenditure that was imported (M).

Government expenditure in Greece occurs in several levels of government, including primarily central and local governments.

Changes in government expenditure are a major component of fiscal policy, used to stabilize the macroeconomic business cycle.

The Central Limit Theorem (CLT) explains why many probability distributions tend to be very close to the normal distribution. The CLT is also known as the second fundamental theorem of Probability Theory. The Law of Large Numbers is the first fundamental theorem, and the Law of the Iterated Logarithm is the third fundamental theorem of Probability Theory. The Law of the Iterated Logarithm tells us what is happening "in between" The Law of Large Numbers and The CLT. Specifically, it says that the normalizing function $\sqrt{nl_n(l_n n)}$, intermediate in size between n of The Law of Large Numbers and $\sqrt{n}$ of The CLT, provides a nontrivial limiting behavior, see Shiryaev (2006). A contemporary version of the CLT is given by A.N.Kolmogorov.

Theorem 1 (CLT)

If all random samples $(x_1, x_2, \ldots, x_n)$ of a reasonably large size n > 30 are selected from any random variable (population) X with finite expectation μ and variance σ^2 then the probability distribution of the sample mean $\bar{x}$ is approximately normal with expectation μ and variance $\frac{\sigma 2}{n}$. This approximation improves with larger samples, as n → ∞, see Kolmogorov (2002).

Theorem 2 (Berry – Esséen)

If the third central moment $E(X-\mu)^3$ exists and is finite, then the above convergence is uniform for all x ∈ (-∞, +∞) and the speed of convergence is at least on the order $\frac{1}{\sqrt{n}}$, see Shiryaev (2006).

Theorem 3 (Arstein – Ball – Barthe – Naor)

The convergence to normal distribution is monotonic in the sense that the entropy of the random variable

$$Z_n = \frac{n(\bar{x} - \mu)}{\sigma\sqrt{n}}$$

increases monotonically to that of the standard normal distribution (Arstein, Ball, Barthe, and Naor, 2004).

The amazing and counterintuitive thing about CLT is that no matter what the probability distribution of the parent population X, the probability distribution of the sample mean $\bar{x}$ approaches a normal curve.

Theorem 1

If a stochastic process $X(t)$ is F_t^0 – martingale, then $E[\,X(t)\,]$ = constant, $\forall t \in \mathrm{N}$.

Theorem 2

If a stochastic process is not F_t^0 – martingale, then it is not also F_t – martingale.

Theorem 3

The stochastic process $\{\,X(t)\,\}, t \in \mathrm{N}$, is a F_t^0 – martingale if and only if the process

$$\{Z(t) = X(t) - X(t-1)\},\ t \geq 2,$$

is a **fair game**. That is, Z(t) follows normal distribution and

$$E[Z(t) \mid F_{t-1}^0] = E[Z(2)] = 0 \qquad , \ \forall t \geq 3.$$

The definition of fair game was given by J. Stein (1974), Nobel Award Winner in Economic Sciences and by Vorobiev (1974), Professor of Mathematics at Moscow University.

"Unfair game" in the sense of Stein -Vorobiev means "speculative game".

In most applications where we wish to test for normality, the population mean μ and variance σ^2 are unknown. In order to perform the Kolmogorov–Smirnov test, we must assume that μ and σ^2 are known. The Lilliefors test, which is quite similar to the Kolmogorov – Smirnov test, overcomes this problem. The major difference between the two tests is that, with the Lilliefors test, the sample mean $\bar{x}$ and the sample standard deviation *s* are used (instead of μ and σ) to calculate the cumulative distribution function *F(x)*. The sample cumulative function *S(x)* and the test statistic

$$D = \max_i |F(x_i) - S(x_i)|$$

are both computed as in the Kolmogorov – Smirnov test. In the Lilliefors test we compare the computed value *D* with the critical value D_c provided by the table of the Lilliefors test.

The SW test for normality compares a set of sample data $(x_1, x_2, \dots, x_n)$ against the normal distribution. The SW test for normality is a very powerful test. This test is of regression type and assesses how well the observed cumulative frequency distribution curve fits the expected normal cumulative curve. The SW test for normality is sensitive to both skewness and kurtosis. In general, SW test is more accurate that KSL test, Cramer – Von Mises test, Durbin test, Chi-squared test, and b_1 test. (Wackearley, Mendenhall, and Schaeffer 2007, Hogg 2009, Field 2013). We use SPSS version 22.

3. Dynamics of quarterly government expenditure

The data set is quarterly government expenditure expressed in thousands of Euro during the period January 2008-September 2015, **see table 1** in Appendix. Using SPSS (version 22, 2014), compute the statistical parameters for the data.

Descriptives

			Statistic	Std. Error
GOVEXP	Mean		10956.406250	321.6334722
	95% Confidence Interval for Mean	Lower Bound	10300.430459	
		Upper Bound	11612.382041	
	5% Trimmed Mean		10906.583333	
	Median		11034.500000	
	Variance		3310338.894	
	Std. Deviation		1819.4336740	
	Minimum		8791.0000	
	Maximum		14067.0000	
	Range		5276.0000	
	Interquartile Range		3608.7500	
	Skewness		.233	.414
	Kurtosis		-1.404	.809

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
GOVEXP	.161	32	.035	.895	32	.005

a. Lilliefors Significance Correction

Test the hypothesis:

H_0: The quarterly government expenditure for Greece during the period January 2008-September 2015 follow a normal distribution.

H_1: The quarterly government expenditure for Greece during the period January 2008-September 2015 follow a non-normal distribution.

Using SPSS, find the significance level p=0.035 for KSL test and p=0.005 for SW test.

Decision Rule:

P<α=0.05 in both cases. Therefore, reject the null hypothesis H_0 at the confidence level 95%.

In other words, the official data of quarterly government expenditure for Greece during the period January 2008-September 2015 contradicts CLT at the confidence level 95%.

-The data set is quarterly government expenditure expressed as a fraction of GDP for Greece during the period January 2008-September 2015. Using SPSS (version 22, 2014), compute the statistical parameters for the data.

Descriptives

			Statistic	Std. Error
GDPPERC	Mean		.213279	.0019762
	95% Confidence Interval for Mean	Lower Bound	.209249	
		Upper Bound	.217310	
	5% Trimmed Mean		.212766	
	Median		.210341	
	Variance		.000	
	Std. Deviation		.0111791	
	Minimum		.1983	
	Maximum		.2385	
	Range		.0402	
	Interquartile Range		.0178	
	Skewness		.597	.414
	Kurtosis		-.656	.809

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
GDPPERC	.153	32	.054	.928	32	.035

a. Lilliefors Significance Correction

Test the hypothesis:

H_0: The quarterly government expenditure for Greece during the period January 2008-September 2015 follow a normal distribution.

H_1: The quarterly government expenditure for Greece during the period January 2008-September 2015 follow a non-normal distribution.

Using SPSS, find the significance level p=0.054 for KSL test and p=0.035 for SW test.

Decision Rule:

P<α=0.05 in both cases. Therefore, reject the null hypothesis H_0 at the confidence level 95%.

In other words, the official data of quarterly government expenditure expressed as a fraction of GDP for Greece during the period January 2008-September 2015 contradicts CLT at the confidence level 95%.

4. The investigation of fair game hypothesis for government expenditure

-The data set is the successive differences in thousands of Euro of quarterly government expenditure for Greece during the period January 2008-September 2015. Using SPSS (version 22, 2014), compute the statistical parameters for the data.

Descriptives

			Statistic	Std. Error
FDIFFGOVEXP	Mean		-111.161290	67.1720964
	95% Confidence Interval for Mean	Lower Bound	-248.345013	
		Upper Bound	26.022432	
	5% Trimmed Mean		-126.917563	
	Median		-80.000000	
	Variance		139874.806	
	Std. Deviation		373.9984043	
	Minimum		-798.0000	
	Maximum		1146.0000	
	Range		1944.0000	
	Interquartile Range		504.0000	
	Skewness		.794	.421
	Kurtosis		3.196	.821

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
FDIFFGOVEXP	.128	31	.200*	.910	31	.013

Using KSL test as well as SW test for normality we test the hypothesis:

H_0: The successive differences of the quarterly government expenditures in thousands of Euro in Greece over the specified period follow a normal distribution.

H_1: The successive differences of the quarterly government expenditures in thousands of Euro in Greece over the specified period follow a non- normal distribution.

We apply the KSL test as well as the SW test for normality Using SPPS (2014) we find the computed value of KSL test= .128 and associated significance level= .200.The computed value of SW statistics is .910, which corresponds to a significance level of .013.

Decision Rule: Reject the null hypothesis H_0 at the confidence level 95%. In other words, the government expenditure process in Greece during the period January 2008-September 2015 is an unfair game at the confidence level 95%.

--The data set is the successive differences of quarterly government expenditure as a fraction of GDP for Greece during the period January 2008-September 2015.

Using SPSS (version 22, 2014), compute the statistical parameters for the data.

Descriptives

			Statistic	Std. Error
FDIFFGDPPERC	Mean		-.000025	.0011787
	95% Confidence Interval for Mean	Lower Bound	-.002432	

			Statistic	Std. Error
		Upper Bound	.002382	
	5% Trimmed Mean		-.000489	
	Median		-.000376	
	Variance		.000	
	Std. Deviation		.0065625	
	Minimum		-.0108	
	Maximum		.0239	
	Range		.0347	
	Interquartile Range		.0075	
	Skewness		1.445	.421
	Kurtosis		4.807	.821

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
FDIFFGDPPERC	.109	31	.200*	.897	31	.006

Using KSL test as well as SW test for normality we test the hypothesis:

H_0: The successive differences of quarterly government expenditure as a fraction of GDP in Greece over the specified period follow a normal distribution.

H_1: The successive differences of quarterly government expenditure as a fraction of GDP in Greece over the specified period follow a non- normal distribution.

We apply the KSL test as well as the SW test for normality Using SPPS (2014) we find the computed value of KSL test= .109 and associated significance level= .200.The computed value of SW statistics is .897, which corresponds to a significance level of .006.

Decision Rule:

Reject the null hypothesis H_0 at the confidence level 95%. In other words, the government expenditure as a fraction of GDP in Greece during the period January 2008-September 2015 is an unfair game at the confidence level 95%.

5. The dynamics of quarterly GDP process

The data set is quarterly GDP in thousands of Euro during the period January 2008-September 2015. Using SPSS (version 22, 2014), compute the statistical parameters for the data.

Descriptives

			Statistic	Std. Error
GDP	Mean		49255.343750	1946.5566505
	95% Confidence Interval for Mean	Lower Bound	45285.315287	
		Upper Bound	53225.372213	
	5% Trimmed Mean		50457.597222	
	Median		48604.000000	
	Variance		121250649.394	
	Std. Deviation		11011.3872602	
	Minimum		.0000	
	Maximum		60546.0000	
	Range		60546.0000	
	Interquartile Range		13902.7500	

	Skewness	-2.857	.414
	Kurtosis	12.654	.809

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
GDP	.273	32	.000	.691	32	.000

Test the hypothesis:

H_0: The quarterly GDP for Greece during the period January 2008-September 2015 follow a normal distribution.

H_1: The quarterly GDP for Greece during the period January 2008-September 2015 follow a non-normal distribution.

Using SPSS, find the significance level p=0.000 for KSL test and p=0.000 for SW test.

Decision rule:

$P<\alpha=0.05$ in both cases. Therefore, reject the null hypothesis H_0 at the confidence level 95%.

In other words, the official data of quarterly GDP for Greece during the period January 2008-September 2015 contradicts CLT at the confidence level 95%.

--The data set is the successive differences of quarterly GDP in thousands of Euro for Greece during the period January 2008-September 2015. Using SPSS (version 22, 2014), compute the statistical parameters for the data.

Descriptives

			Statistic	Std. Error
FDIFFGDP	Mean		-543.838710	140.0247835
	95% Confidence Interval for Mean	Lower Bound	-829.807468	
		Upper Bound	-257.869951	
	5% Trimmed Mean		-591.964158	
	Median		-642.000000	
	Variance		607815.140	
	Std. Deviation		779.6249995	
	Minimum		-1695.0000	
	Maximum		1728.0000	
	Range		3423.0000	
	Interquartile Range		1093.0000	
	Skewness		.896	.421
	Kurtosis		1.110	.821

Tests of Normality

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
FDIFFGDP	.148	31	.083	.944	31	.107

Using KSL test as well as SW test for normality we test the hypothesis:

H_0 : The successive differences of the quarterly GDP in thousands of Euro in Greece over the specified period follow a normal distribution.

H_1 : The successive differences of the quarterly GDP in thousands of Euro in Greece over the specified period follow a non- normal distribution.

We apply the KSL test as well as the SW test for normality Using SPPS (2014) we find the computed value of KSL test= .148 and associated significance level= .083.The computed value of SW statistics is .944, which corresponds to a significance level of .107.

Decision Rule: Accept the null hypothesis H_0 at the confidence level 95%. In other words, the quarterly GDP in Greece during the period January 2008-September 2015 is a fair game at the confidence level 95%.

6. Conclusion

In the present study developed a statistical analysis of the quarterly government expenditure for Greece during the period January 2008-September 2015. The source of the official data is OECD. The government expenditure is estimated based on current price or as a fraction of GDP.

Using Kolmogorov's CLT and the "fair game" concept in Stein-Vorobiev sense, are obtained the following results:

The official data of quarterly government expenditure for Greece during the period January 2008-September 2015 contradicts the CLT at the confidence level 95%.

The official data of quarterly government expenditure expressed as a fraction of GDP for Greece during the period January 2008-September 2015 contradicts CLT at the confidence level 95%.

The government expenditure process in Greece during the period January 2008-September 2015 is an unfair game at the confidence level 95%.

The government expenditure as a fraction of GDP in Greece during the period January 2008-September 2015 is an unfair game at the confidence level 95%.

The official data of quarterly GDP for Greece during the specified period contradicts CLT at the confidence level 95%.

The quarterly GDP in Greece during the specified period is a fair game at the confidence level 95%.

The mean of the quarterly government expenditure as a fraction of GDP in Greece during the period January 2008-September 2015 is 21.32%, the maximum value is 23.85% and the minimum value 19.83%.

The severity of unfair game government expenditure in Greece during the specified period is an obvious feature of the present study.

These results are important for Greece Government and especially for its citizens.

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Appendix, Table 1:

Table 1. Quarterly Government expenditure, quarterly GDP, and their successive differences for Greece during the specified period January 2008-September 2015.

		GDP	FIDIFFGDP	GovExp	FDIFFGOVEXP	GDPPERC	FIDDPERCGDP
	Q1	60,468		12,237		0.202372	
	Q2	60,546	78	12,452	215	0.205662	0.00329
2008	Q3	61, 162	616	12,716	264	0.207906	0.002244
	Q4	59,467	-1,695	12,760	44	0.214573	0.006667
	Q1	58,306	-1,161	13,906	1,146	0.2385	0.023928
	Q2	60,034	1,728	14,067	161	0.234317	-0.00418
2009	Q3	59,453	-581	13,848	-219	0.232923	-0.00139
	Q4	59,907	454	13,453	-395	0.224565	-0.00836
	Q1	58,712	-1,195	13,351	-102	0.227398	0.002833
	Q2	57,293	-1,419	12,627	-724	0.220393	-0.007
2010	Q3	55,791	-1,502	12,142	-485	0.217634	-0.00276
	Q4	54,900	-891	12,008	-134	0.218725	0.001091
	Q1	53,323	-1,577	11,210	-798	0.210228	-0.0085
	Q2	52,392	-931	11,364	154	0.216903	0.006675
2011	Q3	51,479	-913	11,575	211	0.224849	0.007946
	Q4	49,903	-1,576	11,001	-574	0.220448	-0.0044
	Q1	49,197	-706	11,068	67	0.224973	0.004525
	Q2	48,011	-1,186	10,621	-447	0.22122	-0.00375
2012	Q3	47,369	-642	9,969	-652	0.210454	-0.01077
	Q4	46,820	-549	10,078	109	0.21525	0.004796
	Q1	45,964	-856	9,517	-561	0.207053	-0.0082
	Q2	45,360	-604	9,312	-205	0.205291	-0.00176
2013	Q3	44,683	-677	9,241	-71	0.206812	0.001521
	Q4	44,092	-591	9,027	-214	0.204731	-0.00208
2014	Q1	44,078	-14	8,945	-82	0.202936	-0.0018
	Q2	44,010	-68	8,955	10	0.203476	0.000541
	Q3	44,903	893	8,903	-52	0.198272	-0.0052
	Q4	44,149	-754	8,823	-80	0.199846	0.001574
2015	Q1	44,078	-71	8,957	134	0.203208	0.003362

Q2	44,153	75	8,851	-106	0.200462	-0.00275
Q3	43,721	-432	8,830	-21	0.201962	0.0015
Q4	43,609	-112	8,791	-39	0.201587	-0.00038