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Mathematical Modelling: A Study of Corruption in the Society of India

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Abstract: *A study of mathematical model for corruption and its control, that is Mathematical Corruption Model, it is statistically fit as well as valid for measuring corruption in the society. This is the mathematically method for measuring corruption in the society. When quantity of corruption is known, then there is no difficulty to remove the corruption from the society. Sometimes in corruption problems, there is no a priori information available, therefore the Mathematical Corruption Model (or MC model) is known as black box model.*
Keywords: *mathematical thinking, corruption mentality, modeling, applied.*

I. Introduction

A study of mathematical model for corruption and its control, in this connection my research is 'for making a mathematical model to measure the corruption from the society'. We have seen in literature review that the Secretary-General Ban Ki Moon said that there is no scientific and mathematical method for measuring corruption from the society. Therefore we will try to study corruption in the society in different ways that is mathematical study. For collecting the data from Literature Review such as different Research papers from various journals related to the problem corruption in the society and various books of Mathematical modeling. Then we will try to understand the corruption problem. The terms 'corruption', first we will try to explain or define in different ways that is corruption means 'illegal' work or duty or behavior of a person which is living in the society. Such type of concepts we consider the terms 'mathematical effected virus corruption parameter' or 'MEVCP' and it is denoted as variable 'Ƙ'. Then we have seen that the problem of corruption is related to the peoples who are living in the society. So when we calculate growth of population by using applications of differential equations, in this way the corruption problem will solve. By taking the terms 'mathematical corruption parameter' which is related to the negative characters of the peoples in the society of any country in the world and then we take some variables and mathematical relations for making a mathematical corruption model.

By using the application of differential equation, we will form the 'model'. In this model, we use mathematical effected virus corruption parameter then it will become 'corruption model'. Such type of model is known as 'mathematical corruption model'. In this way we make some models such as mathematical corruption growth model in population size as well as in rupees size, mathematical corruption-development model, mathematical decay of corruption model, mathematical development model and mathematical effected virus corruption parameter model. Such type of models is combined known as 'Mathematical Corruption Model'. The function of this model is 'for measuring corruption in the society' as well as 'for removing corruption in the society'. Further by using Mathematical modeling technique, we will make 'Mathematical Corruption Model' for measuring corruption from the society. Such as of the following:

* Mathematical Corruption Growth formula or MC Model:

a] C = $C_0 e^{Kt}$, when Ƙ > 0

b] C = $C_0(K+1)^t$, when Ƙ > 0

* Mathematical Constant Corruption level formula:

C = C_0 , when Ƙ = 0

* Mathematical Decay of Corruption formula or MCC Model:

a] C = $C_0 e^{-Kt}$, when Ƙ ≤ 0

b] C = $C_0(K+1)^{-t}$, when Ƙ ≤ 0

* Mathematical relation between Corruption and Development formula or MCD Model:

a] D(c) = D(0) e^{Kc} , when Ƙ > 0

b] D(C) = D (0) $[1 + K]^C$, when Ƙ > 0

* Mathematical E- virus constant formula or MEVC Model:

a] $\mathbb{K}=\frac{1}{c}\log\frac{D(C)}{D(0)}$, $-1<\mathbb{K}<1$

b] $\mathbb{K}=[\frac{C(t)}{C(0)}]^{\frac{1}{t}}-1$, $-1<\mathbb{K}<1$

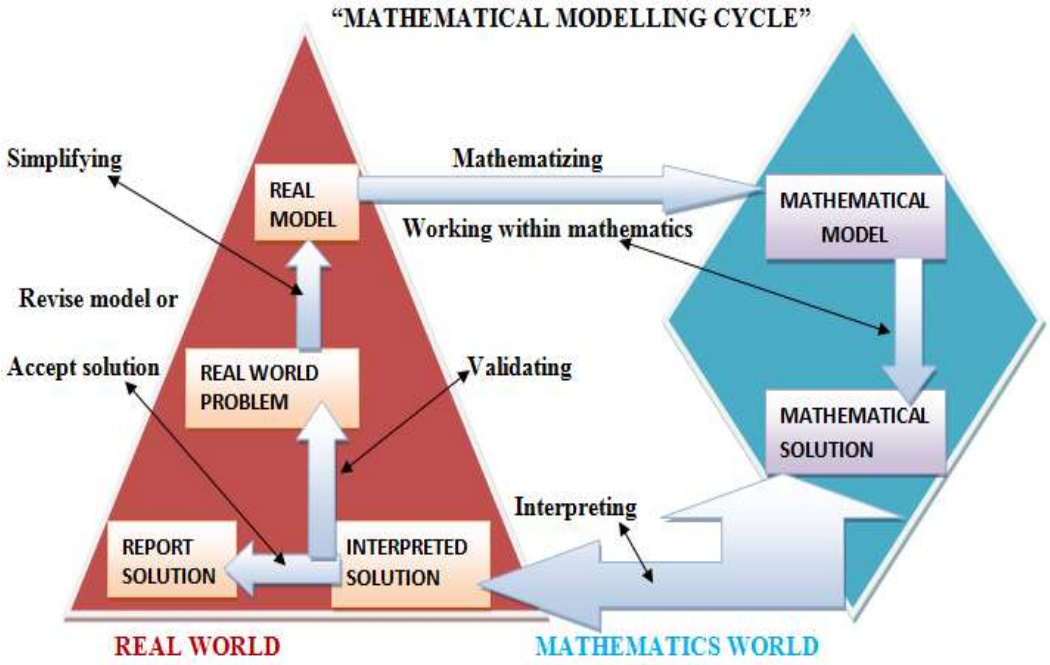
* Mathematical Development Model or MD Model:

a] $D(t) = D(0)\, e^{\mathbb{K}t}$, when $\mathbb{K} > 0$

b] $D(t) = D(0)(\mathbb{K}+1)^t$, when $\mathbb{K} > 0$

II. Methodology

- It is as follows**:**



A modelling task, it requires translations between Mathematics and reality, it is known as mathematical modelling. In reality, it means according to Pollack (1979), he said that the mathematical modeling means "rest of the world" that is outside mathematics including society, nature, and everyday life and other scientific disciplines.

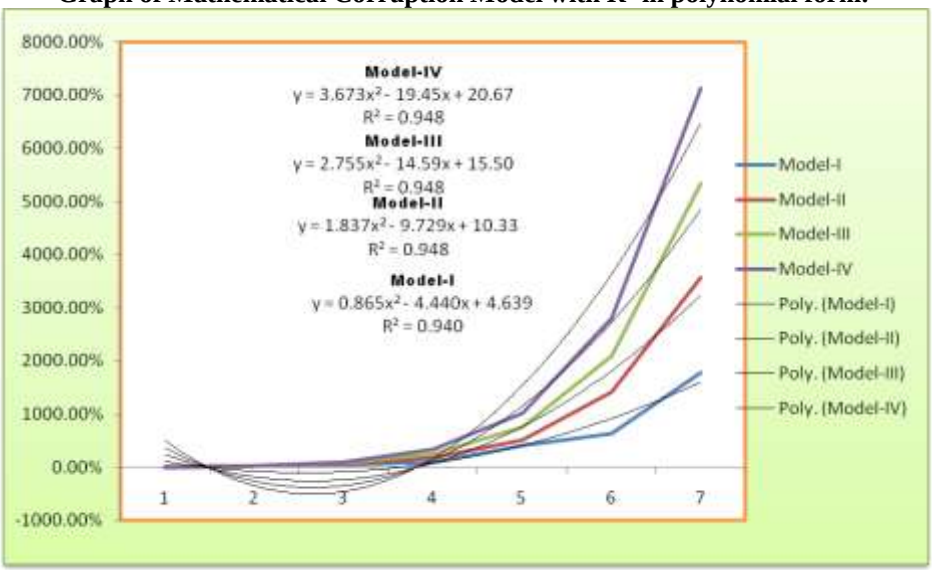
III. Some Illustrations for measuring Corruption in the society

3. Mathematical Corruption growths in various fields of the society (general) in India:

3.1 From Model-I, Model-II, Model-III, and Model-IV, We get final Mathematical Results for corruption in India (in population size). It is as follows:

MEV Constant ' $\mathbb{K}$ '	**Model-I (0.25%)**	**Model-II (0.50%)**	**Model-III (0.75%)**	**Model-IV (1%)**
0	0.0875	0.1750	0.2625	0.3500
0.20	0.2725662	0.5451323	0.8176985	1.0902649
0.40	0.8552174	1.7104348	2.5656522	3.4208695
0.60	4.0241661	5.0843876	7.6265814	10.1687752
0.80	6.2699644	14.0193398	21.0290097	28.0386794
0.9988	17.8059597	35.613963	53.4178793	71.2238390
Regression Square (R^2)	**0.985**	**0.998**	**0.998**	**0.998**

Graph of Mathematical Corruption Model with R^2 in polynomial form:



3.2 Appendix-I: Descriptive Statistics

Model-I: Statistical Study Of Corruption For Model-I

Data x	Sample-I f	f. x	D= (x- X)	D^2	f. D^2
10	0.139979	1.39979	-78	6084	851.632236
20	0.23091603	4.6183206	-68	4642	1071.91221
30	0.39174815	11.7524445	-58	3364	1317.84078
40	0.7500534	30.002136	-48	2304	1728.12303
50	1.32026249	66.0131245	-38	1444	1906.45904
60	2.29883672	137.930203	-28	784	1802.28799
70	4.18174976	292.722483	-18	324	1354.88692
80	7.70885786	616.708629	-8	64	493.366903
90	14.3733307	1293.59976	2	4	57.4933228
100	27.0600136	2706.00136	12	144	3896.64196
	N=$\sum f = 58.456$	$\sum f.x =$5160.74825			$\sum f.D^2 = 14480.6444$

S. D. = σ = 15.739082 $\approx$15.74

Therefore the standard deviation of corruption in India with related period is 15.74.
Here we have observed that standard deviation or inflation in corruption of India for Model-I is 15.74. Therefore it is calculated inflation with related period.

Model-II: Statistical Study Of Corruption For Model-II

Data x	Sample-II f	f. x	D= (x- X)	D^2	f. D^2
10	0.27996	2.7996	-78	6084	1703.27664
20	0.46186	9.2372	-68	4642	2143.95412
30	0.783512	23.50536	-58	3364	2635.73437
40	1.362514	54.50056	-48	2304	3139.23226
50	2.420388	121.0194	-38	1444	3495.04027
60	4.3777496	262.664976	-28	784	3432.15569
70	8.0381248	562.668736	-18	324	2604.35244
80	14.9448366	1195.58693	-8	64	956.469542
90	28.0759678	2526.8371	2	4	112.303871
100	53.2016022	5320.16022	12	144	7661.03072
	N=$\sum f = 114$	$\sum f.x =$10102.4855			$\sum f.D^2 = 27883.55$

S. D. = σ = 15.6428855$\approx$ 15.64

Therefore the standard deviation of corruption in India with related period is 15.64.
Here we have observed that standard deviation or inflation in corruption of India for Model-II is 15.64. Therefore it is calculated inflation with related period.

Model-III: Statistical Study Of Corruption For Model-III

Data x	Sample-III f	f. x	D= (x- X)	D^2	f. D^2
10	0.419937	4.19937	-78	6084	2554.89671
20	0.69274808	13.8549616	-68	4642	3215.73659
30	1.17524445	35.2573335	-58	3364	3953.52233
40	2.04372182	81.7488728	-48	2304	4708.73507
50	3.63048604	181.524302	-38	1444	5242.42184
60	6.56643252	393.985951	-28	784	5148.0831
70	12.0568059	843.976413	-18	324	3906.40511
80	22.41649	1793.3192	-8	64	1434.65536
90	42.1124246	3790.11821	2	4	168.449698
100	79.7993516	7979.93516	12	144	11491.1066
	N=$\sum f$ =170.9136	$\sum f.x = 15117.9$			$\sum f.D^2 = 41824.0124$

S. D. = σ = 15.6431618$\approx$ 15.64

Therefore the standard deviation of corruption in India with related period is 15.64.
Here we have observed that standard deviation or inflation in corruption of India for Model-III is 15.64. Therefore it is calculated inflation with related period.

Model-IV: Statistical Study Of Corruption For Model-IV

Data x	Sample-IV f	f. x	D= (x- X)	D^2	f. D^2
10	0.559916	5.59916	-78	6084	3406.52894
20	0.9236641	18.473282	-68	4642	4287.64875
30	1.5669926	47.009778	-58	3364	5271.36311
40	2.72496242	108.998497	-48	2304	6278.31342
50	4.84064806	242.032403	-38	1444	6989.8958
60	8.75524336	525.314602	-28	784	6864.11079
70	16.0757412	1125.30188	-18	324	5208.54015
80	29.8886536	2391.09229	-8	64	1912.87383
90	56.1498992	5053.49093	2	4	224.599597
100	106.399135	10639.9135	12	144	15321.4754
	N=$\sum f$ =227.88	$\sum f.x$ =20157.2264			$\sum f.D^2 = 55765.35$

S. D. = σ = 15.6433265 $\approx$ 15.64

Therefore the standard deviation of corruption in India with related period is 15.64.
Here we have observed that standard deviation or inflation in corruption of India for Model-IV is 15.64. Therefore it is calculated inflation with related period.
We have seen from Model-I to Model-IV, the Average inflation is 15.64. This inflation is related with the Average Mathematical corruption model.

3.3 Appendix-II: Statistical Study Of Corruption

Data x	Sample Mean f	f. x	D= (x- X)	D^2	f. D^2
10	0.34992825	3.4992825	-78	6084	2128.96347
20	0.58344349	11.6688698	-68	4642	2708.34468
30	0.97891489	29.3674467	-58	3364	3293.06969
40	1.71909124	68.7636496	-48	2304	3960.78622
50	3.04990047	152.495024	-38	1444	4404.05628
60	5.49227635	329.536581	-28	784	4305.94466
70	10.0711448	704.980136	-18	324	3263.05092
80	18.7010505	1496.08404	-8	64	1196.86723
90	35.0911652	3158.20487	2	4	140.364661
100	66.4228065	6642.28065	12	144	9564.88414
	N=$\sum f$ =143	$\sum f.x$ =12597			$\sum f.D^2 = 34966.332$

X=Mean= $\frac{\sum f.x}{N}$ =$\frac{12597}{143}$= 88.090909$\approx$ 88

Therefore, **Mean =88**

We know that the formula for Standard Deviation is as follows:

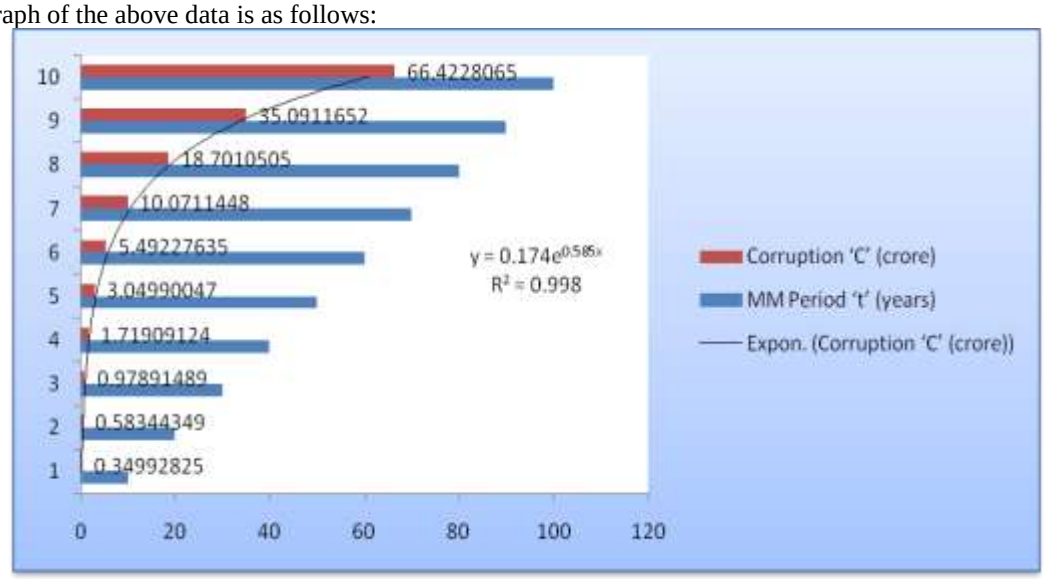
Therefore, S. D. = $\sigma = \sqrt{\frac{\sum fD^2}{N}} = \sqrt{\frac{34966.332}{143}} = \sqrt{244.519804}$

S. D. = σ = 15.637129$\approx$ 15.64

Therefore the standard deviation of corruption in India with related period is 15.64.
Here we have observed that standard deviation or inflation in corruption of India for Average Model is 15.64. Therefore it is calculated inflation with related period.

Statistical Graph of Corruption in India:

The graph of the above data is as follows:

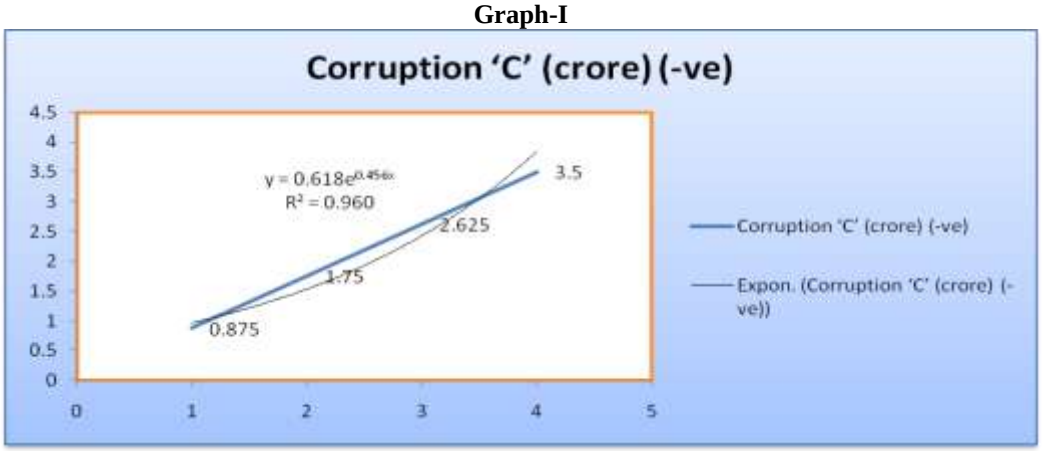


3.4 Appendix-III: Comparative Study Of Mathematical Corruption Model

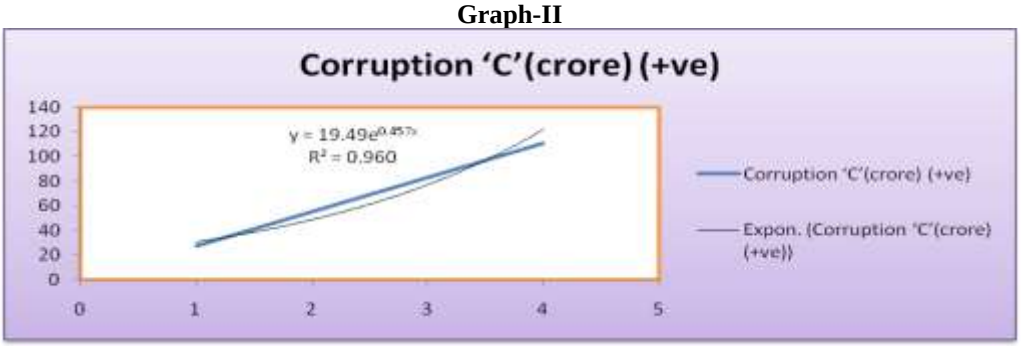
Model	Corruption 'C' (crore) (-ve)	Corruption 'C'(crore) (+ve)	Standard Deviation (S.D.)	Regression Square (R^2)	Average Inflation (CPI) (Real Data)	Gross Inflation (Real Data)
Model-I	0.8750	27.5653738	15.74	0.999	7.979	113.5399
Model-II	1.750	55.3982575	15.64	0.998	7.989	113.5504
Model-III	2.625	83.0943211	15.64	0.998	7.997	113.5589
Model-IV	3.50	110.792428	15.64	0.998	7.998	113.5599
Average Model	**2.1875**	**69.2125951**	**15.64**	-	**7.99**	-
Regression Square (R^2)	**0.960**	**0.960**	-	**0.998**	**0.907**	**0.906**

From the above table, we have seen that the Average Model the population 71.4000951 crore is corrupted but among the 2.1875 crore population is in (-ve) corruption and 69.2125951 crore population is in (+ve) corruption. The graph of above table is as follows:

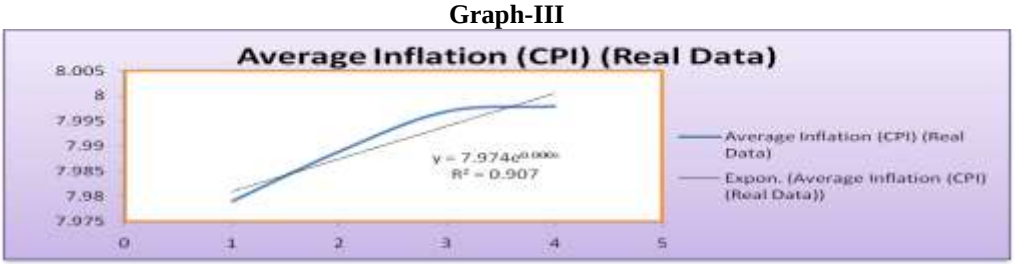
Graph-I



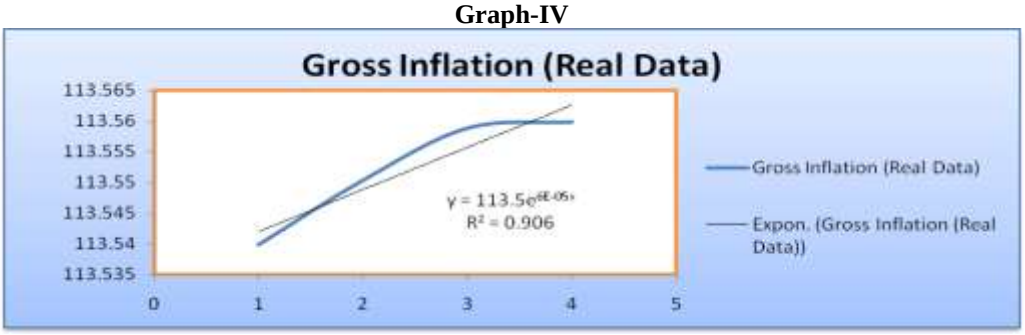
Graph-II



Graph-III



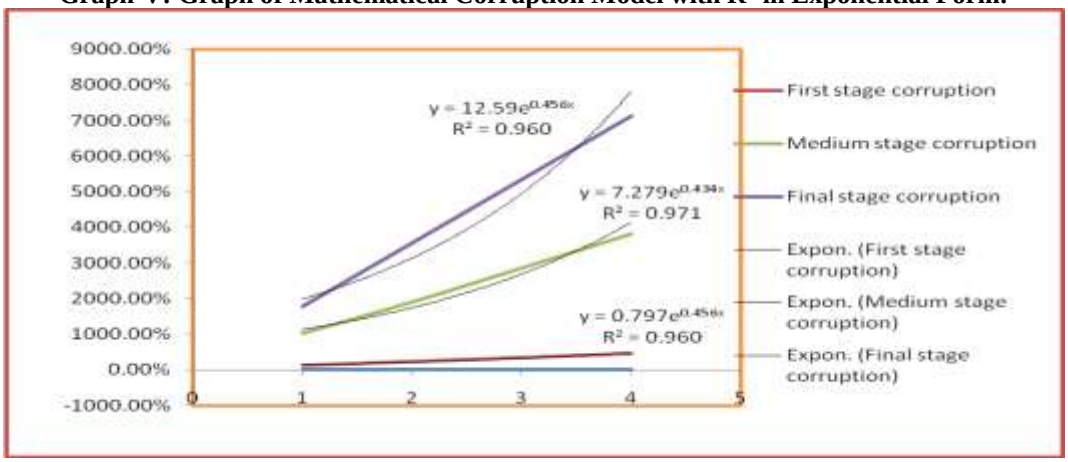
Graph-IV



This shows that the mathematical corruption model is valid for the above illustrations and it is fit statistically. Also we can calculate the corruption in the following type:

Corruption (Population) crore	**Model-I (0.25%)**	**Model-II (0.50%)**	**Model-III (0.75%)**	**Model-IV (1%)**	**Average Model (crore)**	**Regression Square (R^2)**
First stage Corruption	1.1277836	2.2555671	3.3833507	4.5111345	**2.8194590**	**0.960**
Medium stage Corruption	10.2941305	19.1037274	28.6555911	38.2074546	**24.0652259**	**0.971**
Final stage Corruption	17.8059597	35.6139630	53.4178793	71.2238390	**44.5154102**	**0.960**

Graph-V: Graph of Mathematical Corruption Model with R^2 in Exponential Form:



We have observed that from Graph-I, Graph-II, Graph-III, Graph-IV and Graph-V the regression square (R^2) is less than or equal to 1. Therefore the Average mathematical corruption model is fit statistically. Also the mathematical results are valid with the real data of the society of India.

From the table and graph- V, the population distributed in the form of corruption, it is as follows**:**

We know that MCD Model, $D(C) = D(0) \times [1 + \mathbb{K}]^{C}$, here we take $\mathbb{K} = 0.59976$

Therefore C= 71.4000951, D(C) =?

Initially C=0, D (0) = 0.35 crore (1% of 35 crore), therefore MCD Model, we have

When C= 71.4000951 crore, then

$$D(C) = 0.35 \times [1 + 0.59976]^{71.4000951}$$

Therefore D(C) = **129898031223302.47** crore

Also, when C= 2.1875 crore, then

$$D(C) = [2.1875/71.4000951] \times [129898031223302]$$

Therefore, D(C) = **3.979713e12** crore

When C = 69.2125951 crore, then

$$D(C) = [69.2125951/71.4000951] \times [129898031223302]$$

Therefore, D(C) = **1.259183e14** crore

Therefore,

Total population corrupted: 71.4000951 crore, Amount Rs. 129898031223302.47 crore

Among –Ve corruption: 2.1875 crore, Amount Rs. 3.979713e12 crore

Among +Ve corruption: 69.2125951 crore, Amount Rs. 1.259183e14 crore

Also we will try to find the corruption for Average model in the following types,

At First stage corruption, when C = 2.8194590 crore, then

$$D(C) = [2.8194590/71.4000951] \times [129898031223302]$$

Therefore, D(C) = **5.129436e12** crore

At Medium stage corruption, when C = 24.0652259 crore, then

$$D(C) = [24.0652259/71.4000951] \times [129898031223302]$$

Therefore, D(C) = **4.378181e13** crore

At Final stage corruption, when C = 44.5154103 crore, then

$$D(C) = [44.5154103/71.4000951] \times [129898031223302]$$

Therefore, D(C) = **8.098679e13** crore

Therefore,

First stage corruption C = 2.8194590 crore, Amount Rs. 5.129436e12 crore

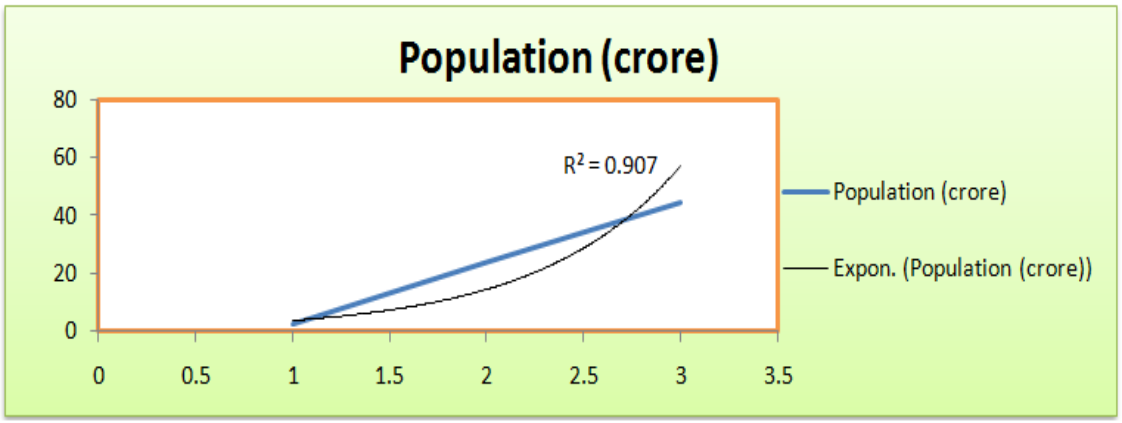
Medium stage corruption C = 24.0652259 crore, Amount Rs. 4.378181e13 crore

Final stage corruption C = 44.5154102 crore, Amount Rs. 8.098679e13 crore

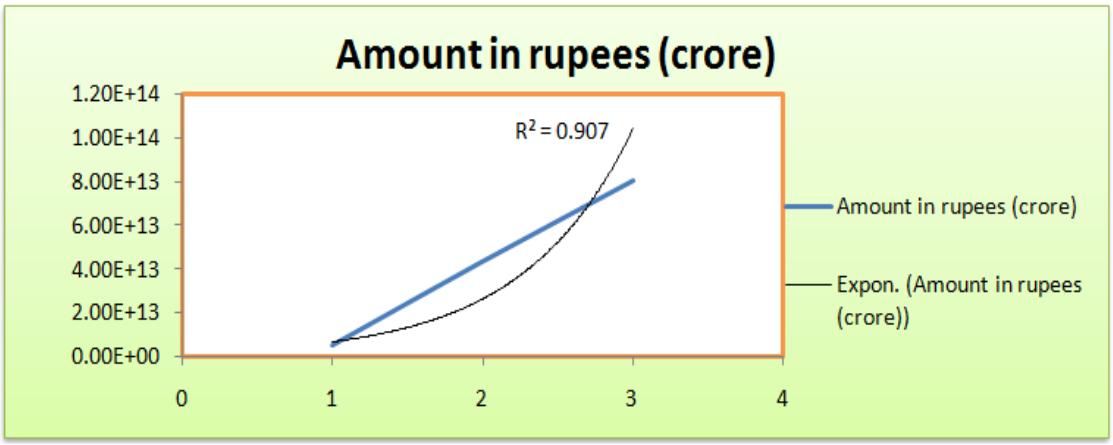
Now we can write the above data in tabular form as follows:

Corruption	**Population (crore)**	**Amount in rupees (crore)**
First stage corruption	2.8194590	5.129436e12
Medium stage corruption	24.0652259	4.378181e13
Final stage corruption	44.5154102	8.098679e13
Regression Square (R^2)	0.907	0.907

Graph-VI



Graph-VII



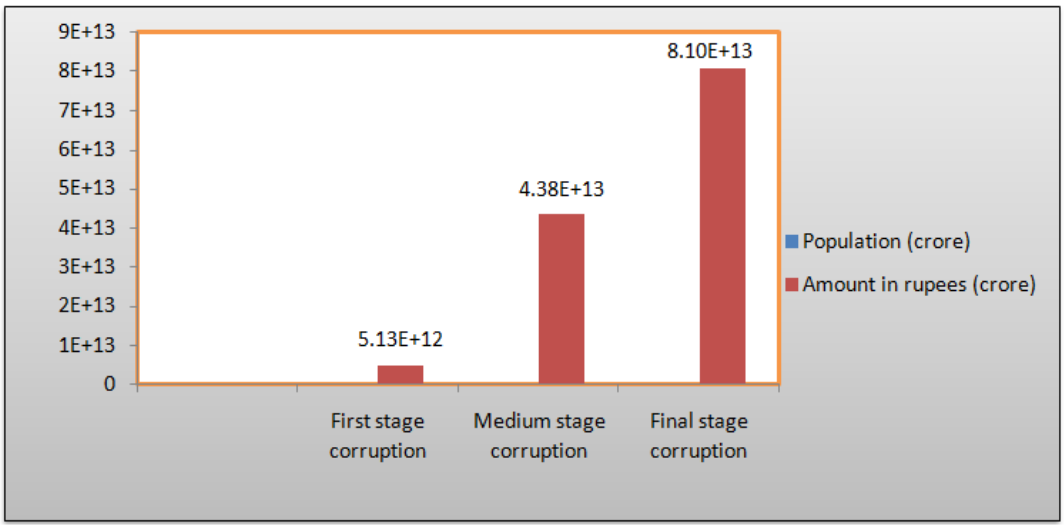
Therefore we have seen all the above various mathematical results and graphs of various illustrations then we can conclude that the mathematical corruption model is fit as well as valid for measuring corruption from the society of the country India or any country of the world. From Appendix-III, we have seen that the Average Model, the population 71.4000951 crore is corrupted but among the 2.1875 crore population is in (-ve) corruption and 69.2125951 crore population is in (+ve) corruption. Also, from Graph the Regression Square (R^2) is less than or equal to 1. Therefore the mathematical corruption model is fit statistically for the above illustrations. It is also valid with the real data of the society in India.

III. Conclusion & Recommendations

We have observed and it concluded that our mathematical results are the mean values of four models with related corruption when the inflation will be approximately 15.64 among 100 years from base after freedom. Then the mathematical results are as follows**:**

First stage corruption:
When $0 < \mathbb{K} \leq 0.40$ C = 2.8194590 crore D(C) = 5.129436e12 crore
Medium stage corruption:
When $0.40 < \mathbb{K} \leq 0.80$ C = 24.0652259 crore D(C) = 4.378181e13 crore
Final stage corruption:
When $0.80 < \mathbb{K} < 1$ C = 44.5154102 crore D(C) = 8.098679e13 crore

Graph of Mathematical Corruption Model of the Society of India



Therefore,
Total population corrupted: 71.4000951 crore, **Amount** Rs. 129898031223302.47 crore
Among –Ve corruption: 2.1875 crore, **Amount** Rs. 3.979713e12 crore
Among +Ve corruption: 69.2125951 crore, **Amount** Rs. 1.259183e14 crore

According to the data provided by the Swiss Banking Association Report (2006), India has more black money than the rest of the world combined. To put things in perspective, Indian-owned Swiss bank Account assets are worth 13 times the country's national debt.

Also we observed that 'the corruption and inflation are related to each other'. When corruption increases then inflation increases and vice versa.

- **Recommendations:**
- To reduce the MEVC parameter Ƙ (to zero) from the society.
- To increase transparency and efficiency of the judiciary.
- To implement strictly laws and statutes in all governments/private offices in India for controlling a bribe. No excuse for minor mistakes also.
- To increase the social welfare in the society.
- To reduce inequality in income.

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