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STABILITY ANALYSIS OF THE EFFECT OF CORRUPTION AMONGST CHRISTIAN LEADERS IN NIGERIAN CHURCHES

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Abstract An epidemiological model of the effect of corruption amongst Christian leaders on church growth was analyzed. We found that a faith-free equilibrium state exists and it is locally asymptotically stable. Furthermore, we investigated the existence of a faithful equilibrium state (FLE) of the model equations. The FLE state of the model is locally and asymptotically stable if the eigen values $\lambda_i = 1,2,3\ and\ 4$ are all negative otherwise, it is unstable.

INTRODUCTION

BACKGROUND OF THE STUDY

Corruption can be seen as a disease that has eaten up to the bone marrow of any infected society. Nigeria, as a nation is not left out to the attack of corruption. Corruption has the power to pull down a nation, no matter how far such a nation has gone. It has penetrated into the religious setting which supposed to be corruption free. In our present generation, Nigeria is known as a nation with the highest number of religious leaders with very large followers, yet corruption has become the greatest threat to the nation. There is no religion now that is corruption free. Churches are not left out. Some People see Christianity as routine and so, not following the context of it. Christianity in this present generation is practiced not displayed. Some men have ceased not to be real men, they have become beasts and so prone to corruption.

Nigeria is a fast-growing religious country in the world with a total land area of about 923, 76859.km [6]. Christians in Nigeria comprise an estimated 49.3% of the population [9]. Nigeria has the largest Christian population of any country in Africa with more than 80 million persons belonging to the church with various denominations [4]. The contrast between religious and the most corrupt is a rapidly growing menace.

Corruption is a product of greed which signifies the use of entrusted wealth or power for private gain or advantage [1]. The corrupt practices decree of 1975 explains corruption as the offer, promise, receipt of any gratification as inducement or reward. The economic and financial crimes commission (EFCC) act empowers the body to prosecute an individual who engages in embezzlement, money laundering and looting amongst others. Hence, corruption whether in the private or public sector denotes an abuse of institutional trust.

However, it is a genetic problem threatening foreign direct investment and prevents sustainable development in Nigeria despite the laws set against it [7]. This so-called pandemic gulps about 40% of the Nigeria 20 billion annual oil income; it subjects Nigerians to unemployment, chronic poverty [3] and its ripple effect has tarnished the country's image around the world.

Corruption can be seen as a marauding beast that is inborn in man but can be subjected because even a baby of 5months knows the level to which to bite the mother's breast for faster milk supply. Corruption which is supposed to be a mortal enemy to Christendom and the church at large has been given a stool to sit on and a staff to head the church.

Many cases of robust outcry on church leaders have been reported without the leaders being questioned or if possible brought to book. The transparency international-2011 corruption perception index (CPI) found out the supposed levels of public sector corruption in 183 nations and regions around the world. Nigeria is categorized as one of the most corrupt countries in the world. However, corruption is not only a Nigerian problem neither did it get its origin from Nigeria but it tends to be that Nigeria has embraced this phenomenon than its origin. Despite the wealth of the churches in Nigeria, the majority of members continue to languish in abject poverty due to the selfish agenda of some leaders who see the church as a personal business [10]. The misallocation of resources due to corruption is responsible for the teaming of aggrieved church members in the country. This has led to the rise of fakes that is becoming a number to worry about.

Another striking effect of corruption is that it begot other sins. Moreover, corruption has also led to a large decline in Christendom, as many losses their enthusiasm. People prefer to be pagans or traditionalists thereby making them to backslide. Sometimes, they get themselves justified by saying that there is no point remaining in Christianity since they do not get what they wanted from the church. The rate of corruption in the church has also to a great extent affected the country Nigeria as a whole. Some church leaders have wonder away from God or have slow degree of leakages of grace which makes their heart desperate for material wealth. In their aspiration to buy a luxurious car, they task members falsely, telling them that it's a command from God thereby leading them to lying and stealing.

However, the status quo can be altered if the anti-corrupt agencies such as the independent corrupt practices and other related offenses, crimes commission (ICPC), EFCC, and code of conduct Bureau (CCB) are permitted to function without interference as well as the effective implementation of the law on individuals with socially deviant behavior, in a competent court of law [2]. The effective implementations of the law are meant to check the executive lawlessness and promote responsible church leaders in Nigeria. Also, there should be an earnest watch by church members who are to serve as a watchdog and adviser to their leaders, if they deviate. If this and more is done, corruption will gradually decay and evaporate out of Nigerian churches and the church will not only be a place to be but a representation of heaven on earth and would be a stepping stone for Nigeria as a nation [11].

Modelling the effect of corruption has to do with displaying and analyzing the extent to which corruption can pierce into the pores of human skin and the aftermath of it. Corruption is now instituted in Nigeria and no doubt an endemic problem that is becoming genetic. Despite the way it has been kicked off by the nation and religious bodies, it is still the subject of our 21st century. Church funds which are to be used for the growth of the church are geared towards worldly things. Excess money from churches which was to be given to orphans, widows upkeep or schooling are now used to purchase items like private jets, expensive cars, bed sheets worth millions and other unnecessary personal wants. All this leads to backsliding of pastors and members. It is discovered that the God of old is nowhere to be found through his miraculous act nowadays

To improve better understanding on the dynamics of Church growth, several mathematical models have been used extensively (see [5, 8] and the references therein).
This study is motivated by the work of [8], on evaluating the impact of active members on Church growth. Therefore, guided by the work in [8] as mentioned above, the present study intends to extend their work by incorporating the compartment of passively possessed infants. Hence, this study intends to investigate the stability analysis of the effect of corruption amongst Christian leaders in Nigerian churches

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2.0 Model Formulation

2.1 The Existing Model

We consider the following assumptions of the existing model in [8] below.

a. The population is compartmentalized into four groups namely: Unbelievers, S(t), Passive Christian, P(t), Active Christians, A(t), all at time t.
b. Unbelievers are converted and recruited into the Church through contact with either an active Church or a passive Church member.
c. The probability that a contact results into a conversion (and hence recruitment) is higher with an active than a passive Church member.
d. Removal (or reversion) does not confer a permanent nor temporal immunity against the Church therefore those who revert enter into the susceptible compartment immediately and can be reconverted.
e. the population is assumed to be homogenously mixed
f. The active period does not start immediately upon conversion. A new convert enters into the passive population and stay for a period of time. Training and listening to "the word" transforms a passive member into active member over time.
g. The passive class is the only gateway in and out of the Church.

Table 1: Parameters of the Existing Model

The existing model in [8] has the following parameters:

Parameters	Description
Λ	the rate at which susceptible individuals are recruited into the population.
β	the average number of effective constant
δ	the rate at which passive individuals(church leaders) "catches enthusiasm" and become active church leaders.
ω	the rate at which passive individuals leaves the church (corruption rate of passive church leaders).
α	the rate at which active individuals (church leaders) looses enthusiasm and become passive.
μ	the natural death rate of all individuals.
m	the effectiveness of an Active member (church leader).

With the above assumptions and parameters by [8], the following model equations were derived

$$\frac{ds}{dt} = \Lambda N - \frac{\beta(p+mA)s}{N} - \mu s + \omega P \quad (1)$$

$$\frac{dp}{dt} = \frac{\beta(P+mA)s}{N} - (\boldsymbol{\omega}+\delta+\boldsymbol{\mu})\, p + \alpha A \quad (2)$$

$$\frac{dA}{dt} = \delta P - (\alpha + \mu)A \quad (3)$$

The Extended Model

In addition to the assumptions of the existing model, we make the following assumptions. We assume that, since evil was unleashed on humanity the battle on our mindset rages fierce and strong which makes us prone to the onslaught of ungodly spirit [12] and prevents one from transcending righteousness (or been free from corruption) unless you are delivered. Therefore, we assume that the compartment of passively possessed infants are susceptible to the attack of ungodly spirit accept they are delivered and recruited into the unbelievers class.

We assume that the possessed compartment changes due to the coming in of the possessed children into the population where we assume that a proportion B of the incoming individual is possessed or resistant to conversion. This compartment reduces due to deliverance rate (δ) and also by natural death, at the rate (μ). In addition, we redefined the notation(Λ) at which unbelievers are recruited into the population in the parameters of the extended model in table 2.

Table 2: Parameters of the Extended Model.

Parameters	Description
Λ	the rate at which Passively possessed infant are recruited into the Population.
$\emptyset$	Deliverance rate of Passively possessed
$R(t)$	Number of Passively possessed infant at time t

The extended model equations are derived based on the above assumptions and parameters.

$$\frac{dR}{dt} = \Lambda N - \emptyset RS - \mu R \quad (1)$$

$$\frac{dS}{dt} = \emptyset RS - \frac{\beta(p+RA)S}{N} - \mu S + \omega p \quad (2)$$

$$\frac{dP}{dt} = \frac{\beta(p+RA)S}{N} - (\omega + \delta + \mu)p + \alpha A \quad (3)$$

$$\frac{dA}{dt} = \delta P - (\alpha + \mu)A \quad (4)$$

Note; $N(t) = R(t)+S(t) + P(t) + R(t) + A(t)$ (5)

The total population$N(t)$, therefore becomes

$$\frac{dN}{dt} = \delta(1 - N) \quad (3)$$

2.3 THE EXTENDED MODEL

$$\frac{dN}{dt} = \Lambda N - \emptyset Rs - \mu R + \emptyset Rs - \frac{\beta(p+RA)s}{N} - \mu S + \omega P + \frac{\beta(p+RA)s}{N} - \omega p - \delta p + \alpha A + \delta p - \alpha A - \mu A$$

$$\frac{dN}{dt} = \Lambda N - \mu R - \mu S - \mu P - \mu A$$

$$\frac{dN}{dt} = \Lambda N - \mu(R + S + P + A) \quad (6)$$

From equation (5), equation (6) becomes

$$\frac{dN}{dt} = (\Lambda - \mu)N \quad (7)$$

We shall transform the model into proportions

Let $a=\frac{R}{N}, b=\frac{S}{N}, c=\frac{P}{N}, e=\frac{A}{N}$

Then $\frac{da}{dt}=\frac{1}{N}\left[\frac{dR}{dt}-a\frac{dN}{dt}\right]$

and $\frac{db}{dt}=\frac{1}{N}\left[\frac{dS}{dt}-b\frac{dN}{dt}\right]$

and $\frac{dc}{dt}=\frac{1}{N}\left[\frac{dP}{dt}-c\frac{dN}{dt}\right]$

and $\frac{de}{dt}-\frac{1}{N}\left[\frac{dA}{dt}-e\frac{dN}{dt}\right]$

From the derivatives above

$$\frac{da}{dt}=\frac{1}{N}[\wedge N-\emptyset Rs-\mu R-e(\wedge-\mu)N]=\frac{\wedge N}{N}-\frac{\emptyset Rs}{N}-\frac{\mu R}{N}-\frac{e(\wedge-\mu)N}{N}$$

$$\wedge-\emptyset Rb-\mu a-e(\wedge-\mu)$$

$$\frac{da}{dt}=\wedge-\emptyset Rb-\mu a-e\wedge+e\mu \quad (8)$$

$$\frac{db}{dt}=\frac{1}{N}\left[\emptyset Rs-\frac{\beta(p+RA)s}{N}-\mu s+\omega p-b(\wedge-\mu)N\right]=\frac{1}{N}[\emptyset Rs-\beta(c+Re)s-\mu s-\omega p-b(\wedge-\mu)N]$$

$$\frac{\emptyset Rs}{N}-\frac{\beta(c+Re)s}{N}-\frac{\mu s}{N}+\frac{\omega p}{N}-\frac{b(\wedge-\mu)N}{N}$$

$$=\emptyset Rb-\beta(c+Re)b-\mu b+\omega c-b(\wedge-\mu)$$

$$\frac{db}{dt}=\emptyset Rb-\beta(c+Re)b+\omega c-b\wedge \quad (9)$$

$$\frac{dc}{dt}=\frac{1}{N}\left[\frac{\beta(p+RA)s}{N}-(\omega+\delta+\mu)p+\alpha A-c(\wedge-\mu)N\right]=\frac{1}{N}[\beta(c+Re)s-(\omega+\delta+\mu)p+\alpha A-c(\wedge-\mu5)N]$$

$$\frac{\beta(c+Re)s}{N}-\frac{(\omega+\delta+\mu)p}{N}+\frac{\alpha A}{N}-\frac{c(\wedge-\mu)N}{N}=\beta(c+R_1e)b-(\omega+\delta+\mu)c+\alpha e-c(\wedge-\mu)$$

$$\beta(c+R_1e)b-(\omega+\delta+\wedge)c+\alpha e \quad (10)$$

$$\frac{de}{dt}=\frac{1}{N}[\delta p-(\alpha+\mu)A-e(\wedge-\mu)N]$$

$$=\frac{\delta p}{N}-\frac{(\wedge+\mu)A}{N}-\frac{e(\wedge-\mu)N}{N}$$

$$\delta c-(\alpha+\mu)e-e(\wedge-\mu)$$

$$\frac{de}{dt}=\delta c-(\alpha+\wedge)e \quad (11)$$

3.4 MODEL ANALYSIS

Existence of faith free equilibrium (EFFE) state

To establish this, we equate the left hand side of equation (8) to (11), we have

$$0 = \wedge - \emptyset Rb - \mu a - e\wedge + e\mu \quad (12)$$

$$0 = \emptyset Rb - \beta(c + me)b + \omega c - b\wedge \quad (13)$$

$$0 = \beta(c + Re)b - (\omega + \delta + \wedge)c + \alpha e \quad (14)$$

$$0 = \delta c - (\alpha + \wedge)e \quad (15)$$

From equation (15)

$$c = \frac{(\alpha+\wedge)e}{\delta} \quad (16)$$

Substituting equation (16) into (14) gives

$$0 = \beta\left(\frac{(\alpha+\wedge)e}{\delta} + Re\right)b - (\omega + \delta + \wedge)\left(\frac{\alpha+\wedge}{\delta}\right)e + \alpha e$$

$$0 = e\left[\beta\left(\frac{(\alpha+\wedge)}{\delta} + R\right)b - (\omega + \delta + \wedge)\left(\frac{\alpha+\wedge}{\delta}\right) + \alpha\right]$$

Dividing both sides by the coefficient of e

$$e = 0$$

Substitute the value of e into equation (15)

$$0 = \delta c - (\alpha + \wedge)(0)$$

$$0 = \delta c$$

$$c = 0$$

Substitute the value of e and c into equation (13) gives

$0 = \emptyset Rb - \beta\big(0 + R(0)\big)b + \omega(0) - b\wedge$

$0 = \emptyset Rb - b\wedge$

$0 = (\emptyset R - \wedge)b$

$b = 0$ or $(\emptyset R - \wedge) \neq 0$

Substitute b and e into equation (12) gives

$0 = \wedge - \emptyset R(0) - \mu a - (0)\wedge + (0)\mu$

$0 = \wedge - \mu a$

$\mu a = \wedge$

$a = \frac{\wedge}{\mu}$

Let a = a*

Then (a,b,c,e) = (a*,0,0,0)

Putting this condition into equation (12) to (15)

$0 = \wedge - a*$

$\boldsymbol{\mu} a^* = \wedge$

$a^* = \frac{\wedge}{\mu}$

we therefore have (a*,0,0,0) = $\left(\frac{\wedge}{\mu}, 0,0,0\right)$ as the FLE state

3.5 FAITHFUL EQUILIBRUM STATE

The faithful equilibrum state is denoted by (a,b,c,e) = (a*,b*,c*,e*)

Solving for a,b,c,e in equation (12) to (15)

From equation (12)

$$a\mu = \wedge - \emptyset Rb - e\wedge + e\mu$$

$$a* = \frac{\wedge - \emptyset Rb - e\wedge + e\mu}{\mu}$$

From (13)

$$0 = (\emptyset m - \beta(c + Re) - \wedge)b + \omega c$$

$$(\emptyset m - \beta(c + Re) - \wedge)b = \text{-}\boldsymbol{\omega} c$$

$$b* = \frac{-\omega c}{\emptyset m - \beta(c+Re) - \wedge}$$

From equation (14)

$$0 = \beta(c + Re)b - (\omega + \delta + \wedge)c + \alpha e$$

$$0 = \beta cb + \beta Reb - \omega c - \delta c - c\wedge + \alpha e$$

$$0 = (\beta b - \omega - \delta - \wedge)c + (\beta Rb + \alpha)e$$

$$c* = -\frac{(\beta Rb+\alpha)e}{\beta b - \omega - \delta - \wedge}$$

From equation (15)

$$0 = \delta c - (\alpha + \wedge)e$$

$$-\delta c = -(\alpha + \wedge)e$$

$$e^* = \frac{\delta c^*}{(\alpha+\wedge)}$$

Now putting a* in b* in c* and e* we have

$$b^* = -\frac{\omega c^*}{\emptyset Rb\left(c^*+\frac{R\delta c^*}{\alpha+\wedge}\right)-\wedge}$$

$$c^* = \frac{(\emptyset m-\wedge)(\alpha+\wedge)[(\omega+\wedge)(\alpha+2\wedge)+\wedge\delta]}{\beta\wedge(\alpha+\wedge+R\delta)(\alpha+2\wedge+\omega+\delta)}$$

$$e^* = \frac{\delta(\emptyset R-\wedge)[(\omega+\wedge)(\alpha+2\wedge)+\wedge\delta]}{\beta\wedge(\alpha+\wedge+R\delta)(\alpha+2\wedge+\omega+\delta)}$$

2.6 STABILITY

By linearization method

Let $F_1 = \wedge - \emptyset Rb - \mu a - e\wedge + e\mu$

$F_2 = \emptyset Rb - \beta(c + Re)b + \omega c - b\wedge$

$F_3 = \beta(c + Re)b - (\omega + \delta + \wedge)c + \alpha e$

$F_4 = \delta c - (\alpha + \wedge)e$

Then,

$$\frac{\partial f_1}{\partial a^*} = -\mu, \frac{\partial f_1}{\partial b^*} = -\emptyset R, \frac{\partial f_1}{\partial c^*} = 0, \frac{\partial f_1}{\partial e^*} = -\wedge + \boldsymbol{\mu}$$

$$\frac{\partial f_2}{\partial a^*} = 0, \frac{\partial f_2}{\partial b^*} = \emptyset R - \beta(c + Re) - \wedge, \frac{\partial f_2}{\partial c^*} = -\beta b + \omega, \frac{\partial f_2}{\partial e^*} = -\beta Rb$$

$$\frac{\partial f_3}{\partial a^*} = 0, \frac{\partial f_3}{\partial b^*} = \beta(c + Re), \frac{\partial f_3}{\partial c^*} = \beta cb - (\omega + \delta + \wedge), \frac{\partial f_3}{\partial e^*} = \beta Rb + \alpha$$

$$\frac{\partial f_4}{\partial a^*} = 0, \frac{\partial f_4}{\partial b^*} = 0, \frac{\partial f_4}{\partial c^*} = \delta, \frac{\partial f_4}{\partial e^*} = -(\alpha + \wedge)$$

$$J^* = \begin{bmatrix} -\mu & -\emptyset R & 0 & -\wedge+\mu \\ 0 & \emptyset R_1 - \beta(c+Re) - \wedge & -\beta b + \omega & -\beta Rb \\ 0 & \beta(c+Re) & \beta cb - (\omega+\delta+\wedge) & \beta Rb + \alpha \\ 0 & 0 & \delta & -(\alpha+\wedge) \end{bmatrix}$$

At FLE state $(a^*,0,0,0) = (\frac{\wedge}{\mu}, 0,0,0)$

$$J_o = \begin{bmatrix} -\mu & -\emptyset R & 0 & -\wedge+\mu \\ 0 & \emptyset R - \wedge & \omega & 0 \\ 0 & 0 & -(\omega+\delta+\wedge) & \alpha \\ 0 & 0 & \delta & -(\alpha+\wedge) \end{bmatrix}$$

To determine the eigen values, we employ the equation

$$[J_\circ - \lambda I] = 0$$

$$[J_\circ - \lambda I] = \begin{bmatrix} -\mu-\lambda & -\emptyset R & 0 & -\wedge+\mu \\ 0 & \emptyset R - \wedge - \lambda & \omega & 0 \\ 0 & 0 & -(\omega+\delta+\wedge)-\lambda & \alpha \\ 0 & 0 & \delta & -(\alpha+\wedge)-\lambda \end{bmatrix} = 0$$

$$(-\mu-\lambda)\begin{bmatrix} \emptyset R - \wedge - \lambda & \omega & 0 \\ 0 & -(\omega+\delta+\wedge)-\lambda & \alpha \\ 0 & \delta & -(\alpha+\wedge)-\lambda \end{bmatrix} = 0$$

$$(-\mu-\lambda)(\emptyset R - \wedge - \lambda)[(\omega+\delta+\wedge+\lambda)(\alpha+\wedge+\lambda) - \alpha\delta] = 0$$

Either $-\mu-\lambda = 0$ or $\emptyset m$-$\wedge$-λ =0

Which implies $\lambda_1 = -\boldsymbol{\mu}$ ***or*** $\boldsymbol{\lambda_2 = \emptyset m - \wedge}$

or

$$(\omega+\delta+\wedge+\lambda)(\alpha+\wedge+\lambda) - \alpha\delta = 0$$

$$\lambda^2 + \lambda(\omega+\delta+\alpha+2\wedge) + (\wedge(\omega+\delta+\alpha+\wedge) + \omega\delta)$$

and

By applying the quadratic formula we have

$a = 1, b = \omega + \delta + \alpha + 2\wedge,\ c = (\boldsymbol{\omega\alpha} + \wedge(\boldsymbol{\omega} + \boldsymbol{\delta} + \boldsymbol{\alpha} + \wedge))$

$$\lambda_{(3,4)} = \frac{-(\omega+\delta+\alpha+2\wedge) \pm \sqrt{(\omega+\delta+\alpha+2\wedge)^2 - 4(\boldsymbol{\omega\alpha}+\wedge(\boldsymbol{\omega}+\boldsymbol{\delta}+\boldsymbol{\alpha}+\wedge))}}{2}$$

$$\lambda_{(3,4)} = \frac{-A_1 \pm \sqrt{{A_1}^2 - 4A_2}}{2}$$

Where,

$A_1 = \omega + \delta + \alpha + 2\wedge$

$A_2 = \boldsymbol{\omega\alpha} + \wedge(\boldsymbol{\omega} + \boldsymbol{\delta} + \boldsymbol{\alpha} + \wedge)$

Let ${A_1}^2 - 4A_2 > 0$

Therfore,

$$\lambda_3 = \frac{-A_1 - \sqrt{{A_1}^2 - 4A_2}}{2} < 0$$

Also,

$$\lambda_4 = \frac{-A_1 + \sqrt{{A_1}^2 - 4A_2}}{2} < 0$$

if and only if

$$\lambda_4 = \frac{-A_1 - \left(-\sqrt{{A_1}^2 - 4A_2}\right)}{2} < 0$$

$$\lambda_4 = \frac{-A_1 - \sqrt{4A_2 - {A_1}^2}}{2} < 0$$

if

$$4A_2 > {A_1}^2$$

Then,

$$A_1 < \sqrt{2A_2}$$

Since

$\lambda_i < 0, i = 1,2,3\ and\ 4$, we can hence conclude that the FLE state is locally asymptotically stable, otherwise, it is unstable.

Results of stability analyses

Preposition 1

The FLE state of the model (3.17)-(3.23) is locally and asymptotically stable if the associated the eigen values $\lambda_i = 1,2,3\ and\ 4$ are negative otherwise, it is unstable.

Conclusion

we established that reducing the rate at which active Christian loses their trust or faith (enthusiasm), and inactive Christian rise to fakes or live the church (backslide) will decrease corruption burden if control effort through corruption crusade, conviction, and being deposed (removed) should be adequately implemented.

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