Formal Stability Analysis of Common

Lending Practices and Consequences of Chronic Currency Devaluation

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Abstract:

This document is the result of a rigorous control system theory stability analysis of the current world de facto standard currency system and identifies a root instability in the form of the growth component of Debt associated with the money creation process. It first establishes the inherent instability of Common Lending Practices (application of interest). Then the analysis further charts the logical consequences of said root instability as it affects the economy as a whole and identifies how it provokes a systematic divergence between debt and value attributed to wealth in past cycles with the minimum value required in current and future cycles as those incorporate past unpaid debt. i.e. systematic compounding of debt. It also identifies how the only means available within the system design for staving off inflation is through the continued contribution of collateral wealth as guaranty for the creation of new principal debt money commensurate with past debt growth. Finally it illustrates that compounding debt inevitably leads to a point where an inability to provide new wealth to guaranty new money to keep up with debt growth becomes chronic at which point either runaway inflation or a definitive collapse of the system inevitably ensues.

INTRODUCTION

The goal of this document is to provide a formal stability analysis study of common lending practices and their consequences. Stability is a crucial property of physical and abstract (social, economic) systems: assuming linearity in the system model, implies that only one equilibrium point can be defined for the system. That point is where the system keeps operating with all its variables fixed at a constant value. If such a point can be defined (in the absence of an input, for linear systems there is only one, which corresponds to system inactivity i.e. when both input and output are zero), instability occurs when any change in input no matter how small drives the output to infinity[1]. In the loan model analyzed in this document, input is the principal of a loan, and output is the debt generated, beyond the input as a function of time. Therefore, it can be

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[1] Mathematical stability of linear and non linear dynamic systems were thoroughly studied by A. Lyapunov. The stability concepts cited herein are extracted from this work,, and broadly applied in control theory.

stated that a loan system will be unstable when for a given loan; the debt it originates grows to infinity as a function of time.

The test for the inherent stability or instability of these lending practices themselves requires that the loan processes as defined continue to their last and full logical outcome without the need for other hypothetical conditions such as intermittent reductions of principle during the course of the loan.[2].

Therefore, to the extent to which the loan models herein have been analyzed, instability is identified for any of the cases where either part of the principal loan or the interest on that amount cannot be paid whatever the reason, in which case the debt will continue to grow towards infinity.

In this study, assumptions have been made in an effort to provide the most favourable case for stability among common lending practices, i.e. the analysis first considers the case where simple interest is applied to be followed later by the case of anatocism (compound interest).

As Annex I an experimental design is provided that can be performed by anyone to verify the following hypothesis that can be gleaned from the conclusions of this paper:

"No matter the nature of wealth traded in an economy or the relative success or failure of economic activity or the nature or behaviour of the participants, "Common Lending Practices" as described in this document, will always exhibit unbounded outputs in the form of residual interest bearing debt beyond the bounded value attributed to discreet and finite wealth and beyond the sum of money created in the form of the principal sum of loans."

1. SIMPLE INTEREST MODEL

Here, the mechanism used in the analysis for loan retribution is simple interest, as well as the application of a penalty interest (usually very high) to unpaid loan instalments. Therefore, only linear equations are included; linear equations give rise to linear models, where the stability discussion included in the Introduction of this document is applied.

The model has been established on a discrete time basis, as this represents the common way that plain users make their payments, on a weekly-monthly or periodic basis. This assumption in no way diminishes the applicability of this analysis, as this is only a periodic view of a continuous-time process of increasing debt on the basis of interest applied. Note that the condition for the application of linear stability is linearity itself, no matter whether the model is continuous or discrete.

[2] This test corresponds to what is known as the step input response evaluation in control theory. In linear systems, it provides all the proof required to state whether a system is stable or not and there is no inbetween position on this.

The analysis tool that has been used to arrive at the conclusions has been the Z transform[3]. This tool is commonly used in analysis of linear time invariant (LTI) discrete and sampled[4] models in control theory.

Model Variables:

P	Principal of the loan
Y	Total debt in each period
I	Cumulative regular interests produced by the loan
X	Total funds paid to cancel I
R1	Total regular interest not covered by X
D	Cumulative penalty interests produced by R1
W	Total funds paid to cancel D
R2	Total penalty interest not covered by W

Behaviour of the variables:

- P, X and W are the inputs to the model. The origin of these variables[5] is irrelevant to the goal of this analysis. They represent cumulative quantities, i.e. if some funds are paid to cover the principal of the debt P diminishes accordingly. Similarly, X and W represent cumulative funds in the sense that any funds paid to cover whatever kind of interest increases X or W accordingly.

Parameters of the model

r1	Rate for the regular interest
r2	Rate for the penalty interest
k	The period in which variables take their present value

Behaviour of the parameters:

- For this analysis it is assumed that interest rates are kept constant for the life of the loan. It could be argued that they can be modified in both senses (growing or diminishing) during the life of the loan; in the case that this were to be true, the only consequence is a change in the growth rate of the total debt. Therefore the hypothesis holds true for all cases except the cases that if the interest rates are negative, i.e. when loans are credited

[3] Intermediate calculations have been removed for readability

[4] A system is discrete when its variables take on values only in discrete points in time. It is a sampled system if it is continuous but values of its variables are considered only for a given set of points in time, usually at equally spaced points in time (periodic sampling). The loan model should be considered as a sampled system, since the interest grows continuously in time, but is only evaluated at given times (i.e. end of each installment period).

[5] I.e. how the money used to make these payments is generated or obtained has no bearing.

over time, not penalized: in this analysis this possibility is neglected, as long as, although possible, it is highly improbable, and therefore not representative of common practices.

- The parameter k is an integer, indicating the k-th period of the loan, whatever the period a week, month etc. This means that wherever the k subscript appears it indicates that the variable takes on its value for the k-th period portion of the loan's life.

Model Equations

- Evolution of total debt

$$Y_k = P_k + R_{1\ k} + R_{2\ k} = P_k + (I_k - X_k) + (D_k - W_k)$$

- Evolution of regular interest

$$I_k = I_{k-1} + r_1 P_{k-1}$$
$$I(z) = I(z)z^{-1} + r_1 P(z)z^{-1}$$
$$I(z)(1 - z^{-1}) = r_1 P(z) z^{-1} \Rightarrow \frac{I(z)}{P(z)} = \frac{r_1 z^{-1}}{1 - z^{-1}} = \frac{r_1}{z - 1}$$

- Evolution of penalty interest

$$D_k = D_{k-1} + r_2 R_{1\ k-1}$$
$$D(z) = D(z)z^{-1} + r_2 R_1(z)z^{-1}$$
$$D(z)(1 - z^{-1}) = r_2 R_1(z) z^{-1} \Rightarrow \frac{D(z)}{R_1(z)} = \frac{r_2 z^{-1}}{1 - z^{-1}} = \frac{r_2}{z - 1}$$

- Unpaid regular interest

$$R_{1\ k} = I_k - X_k$$

- Unpaid penalty interest

$$R_{2\ k} = D_k - W_k$$

- Complete model dynamics

$$Y(z) = P(z) + \frac{r_1}{z-1}P(z) - X(z) + \frac{r_2}{z-1}R_1(z) - W(z) =$$

$$= \quad P(z) + \frac{r_1}{z-1}P(z) - X(z) + \frac{r_2}{z-1}\left(\frac{r_1}{z-1}P(z) - X(z)\right) - W(z) =$$

$$\Rightarrow \quad Y(z) = P(z)\left[1 + \frac{r1}{z-1} + \frac{r_1 r_2}{(z-1)^2}\right] - X(z)\left[1 + \frac{r_2}{z-1}\right] - W(z)$$

Model analysis

From the above the following can be stated:

- The model is linear-time-invariant (LTI) and discrete [6].
- There are three inputs, corresponding to the funds paid to cover the principal (variations in P), to cover the regular interest (X), and to cover the penalty interest (W).
- Since the model is linear, it can be analyzed using the superposition principle: the effect of each input can be isolated from the others' by simply eliminating those others.
- From stability theory it can be straightforwardly asserted that the model is intrinsically unstable [7]. This conclusion is easily explained by virtue of the cumulative nature of interest, and if any amount remains unpaid, debt grows to infinity in the absence of triggering some saturation mechanism.

Simulation of the model

- Regular interest loan

The hypothesis for this simulation is a loan where only the regular interest is paid at the end of each period. This means that no reduction on the principal of the loan is provided[8].
Given these conditions, the evolution of debt as time goes by is represented by the formula:

$$y_k = P(1 + k\, r_1)$$

The figures for the simulation are the following:

- Principal of the loan P=1000
- Regular interest rate r1=0.05/12 (i.e. 5% in a year paid on a monthly basis)

Given these values for the model parameters, the evolution of the debt is:

$$y_k = 1000\,(1 + 0.0041666k)$$

The outcome of the model is the cumulative debt produced by this loan.

This means that both principal and interests (already paid) are summed up to give the total value of the debt.

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[6] As long as the constancy of interest rates hypothesis holds. It has been stated already that it can be assumed without loss of generality

[7] All the poles (roots of the polynomials in the denominators) of the model are placed on z=1. Moreover, it is widely known that for linear systems (in-) stability is an intrinsic property, i.e. it does not depend on the input to the system or the initial condition.

[8] Mathematically, it is completely equivalent to the evolution of the debt where no principal or interest are paid, but no penalty interest nor interest composition (anatocism) are applied.

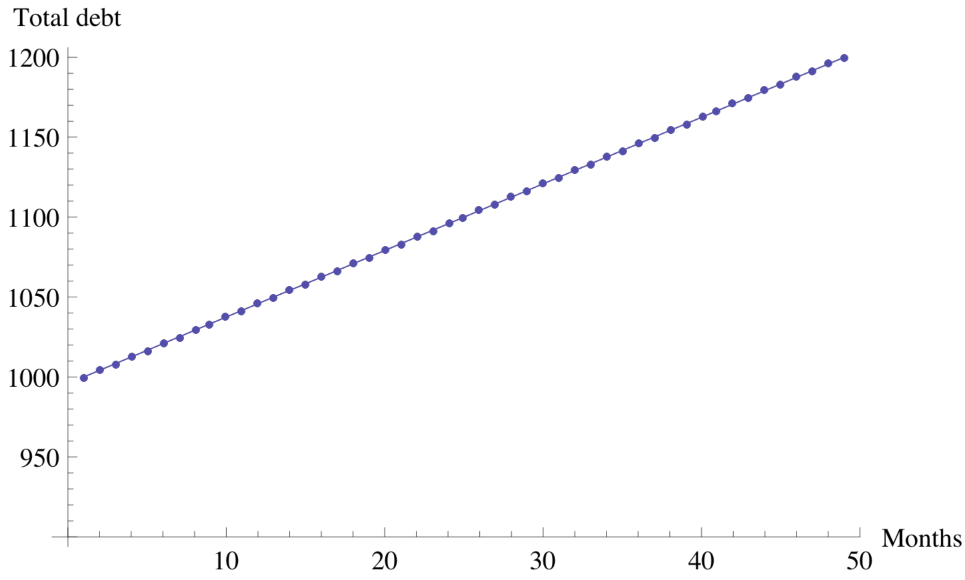

Fig. 1 Linear Simple Interest only

From the diagram above it can be clearly stated that, if no reduction of principal is produced, the total debt grows to infinity in a linear fashion. Out of the concept of BIBO[9] stability (commonly used in LTI systems control), it can be undoubtedly stated that the system is unstable.

- Loan with regular and penalty interest

The hypothesis for this simulation is a loan where no funds are paid at any time, i.e. no principal, regular or penalty interests are paid. This represents a situation where the debt grows due to two causes: on the one hand it has a linear growth due to the application of regular interest to the principal and on the other, a second linear factor, which is composed with the first, due to the application of penalty interest to the unpaid regular interest; this composition results in quadratic growth of the debt.
Under the abovementioned conditions, the evolution of debt is:

$$y_k = \frac{1}{2} P \left(2 - k\, r_1(-2 + r_2) + k^2\, r_1 r_2\right)$$

The figures for the simulation are the following:

- Principal of the loan P=1000
- Regular interest rate r1=0.05/12 (i.e. 5% in a year paid on a monthly basis)
- Penalty interest rate r2=0.2/12 (i.e. 20% in a year paid on a monthly basis)

[9] BIBO, Bounded Input-Bounded Output. For a linear system to be stable, any bounded input must generate a bounded output. Otherwise, the system is unstable.

Given these values for the simulation, the evolution of the total debt is:

$$y_k = 1000\left(1 + 0.00413194k + 0.0000347222k^2\right)$$

The outcome of the model is the cumulative debt produced by this loan. This means that principal, unpaid regular interests and penalty interests are summed up to give the total value of the debt.

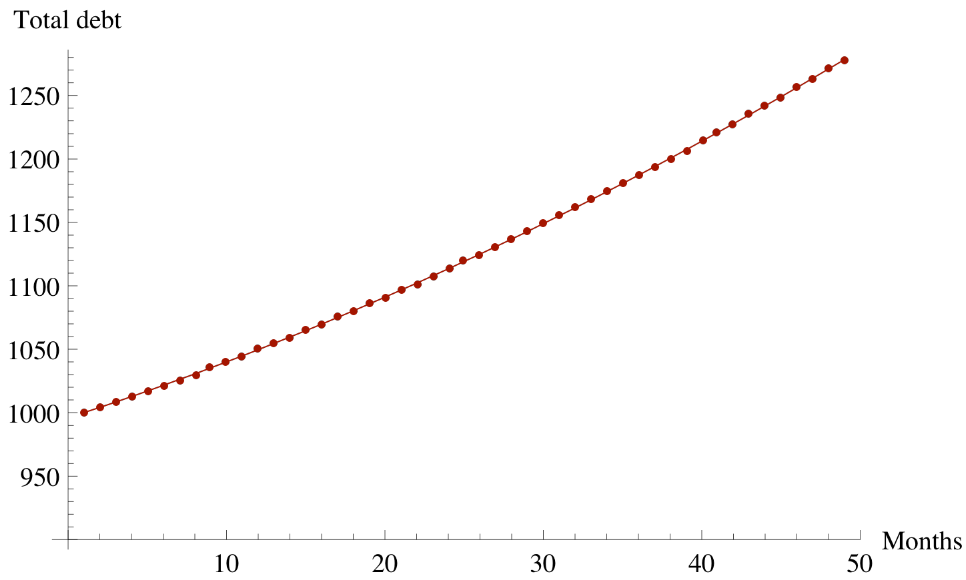

Fig. 2 Simple Interest + Penalty Interest quadratic growth

From Fig. 2 above it can be clearly stated that, if no reduction of principal is produced and as the regular interest remains unpaid, the total debt grows to infinity in a quadratic fashion. Out of the concept of BIBO stability, again it can be undoubtedly stated that the system is unstable.

Moreover, comparing both graphs (below), it's clear that penalty interests accelerate debt growth.

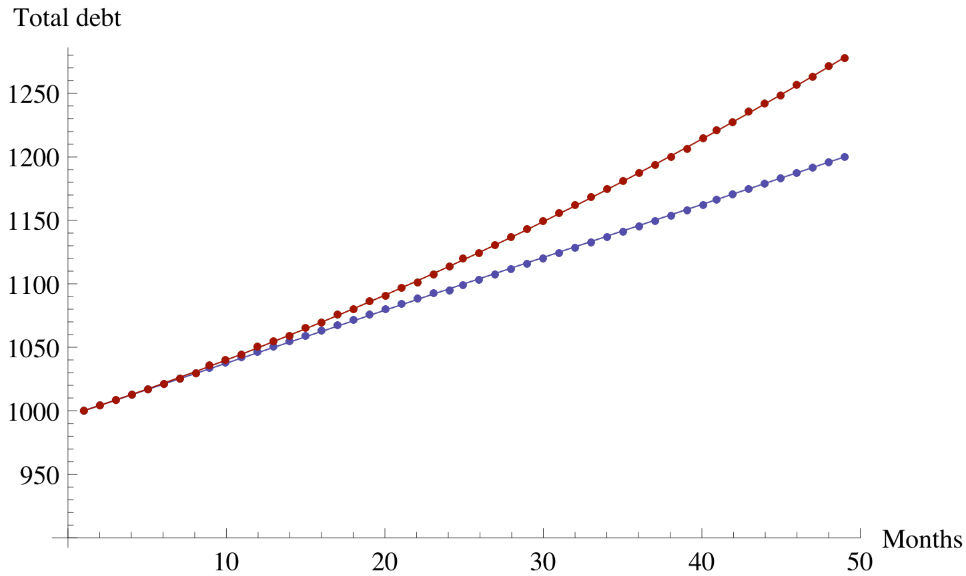

Fig. 3 Linear and Quadratic Debt Growth

2. COMPOUND INTEREST LOAN MODEL

Although compound interest is a prohibited practice in many countries for at least personal loans, it is interesting to study its stability as well, since it is present in our banking system to reward savings (positive balances), and, as will be demonstrated hereafter, also arises as a consequence of the refinancing debts[10].

As for the case of a standard loan, the tools used for the analysis are discrimination on the basis of the payment periods, and Z transform as analysis tool for discrete systems.

Model variables

P	Principal of the loan
Y	Total debt in each period
I	Cumulative interests produced by the loan
X	Total funds paid to cancel I

Behaviour of the variables:

- P and X are the inputs to the model. As before, the origin of these variables is irrelevant to the goal of the analysis. They represent cumulative quantities, i.e. if some funds are paid to cover the principal of the debt P diminishes accordingly. Similarly, X represent cumulative funds in the sense that any funds paid to cover the interest increase X accordingly.

Parameters of the model

r	Rate for the regular interest
k	The period in which variables take their present value

Behaviour of the parameters:

- For this analysis it is assumed that the interest rate is kept constant for the life of the loan. The discussion for this hypothesis is provided for in the standard loan; please, refer to that section for more information.
- The parameter k is an integer, indicating the k-th period of the loan, whatever the period a week, month etc. This means that wherever the k

[10] Refinancing a debt is equivalent to updating the principal value including both previous principal and unpaid interest. This practice is completely equivalent to interest composition (anatocism), but produced at will (not forced by the loan conditions) and seldom (not in periods forced by the loan conditions)

subscript appears it indicates that the variable takes on its value for the k-th period portion of the loan's life.

Equations of the model

- Evolution of total debt

$$Y_k = P_k + I_k - X_k$$

- Evolution of interest
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- $I_k = rY_{k-1} + I_{k-1}$

- Complete model dynamics

$$Y(z) = P(z) + \frac{r}{z-1}Y(z) - X(z)$$

$$Y(z)\left[1 - \frac{r}{z-1}\right] = P(z) - X(z)$$

$$Y(z)\frac{z-(1+r)}{z-1} = P(z) - X(z)$$

$$\Rightarrow \quad Y(z) = (P(z) - X(z))\frac{z-1}{z-(1+r)}$$

Model analysis

From the above the following can be stated:

- The model is linear- time -invariant (LTI) and discrete.
- There are two inputs, corresponding to the funds paid to cover the principal (variations in P) and to cover the regular interest (X).
- Since the model is linear, it can be analyzed using the superposition principle: the effect of each input can be isolated from the others' by simply eliminating those others.
- From stability theory it can be straightforwardly asserted that the model is intrinsically unstable. This conclusion is easily explained by virtue of the cumulative nature of the interest that increases the principal of the loan if unpaid, making debt grow to infinity unless some saturation mechanism is triggered.

Simulation of the model

The hypothesis for this simulation is a loan where no interest is paid and no reduction on the principal of the loan is provided[11].

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[11] It is straight forwardly proved that if the interest is regularly paid, principal doesn't grow and the behavior of the loan is the same as a standard loan (linear growth of the debt)

The evolution of debt under these conditions is given by:

$$y_k = P(1 + r)^k$$

The figures for the simulation are the following:

- Principal of the loan P=1000
- Regular interest rate r1=0.05/12 (i.e. 5% in a year charged on a monthly basis)

Given these values for the model parameters, the evolution of the debt is:

$$y_k = 1000 \times 1.00417^k$$

The outcome of the model is the debt produced by this loan at the end of each period.

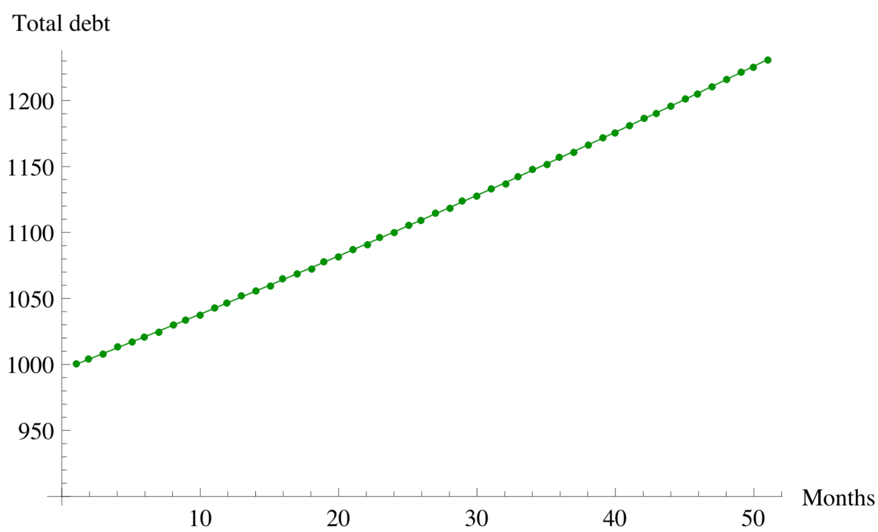

Fig. 4 Compound Interest

In the figure above the behaviour of the debt can be seen. The first conclusion, again out of the concept of BIBO stability, is that the system shows an unbounded output, and therefore is unstable. Another salient feature is that although the growth is exponential, it is so smooth that it could be thought to be quasi-linear. However, comparing this output to those of the standard and the penalized interest (below), it can be seen that it is not linear.

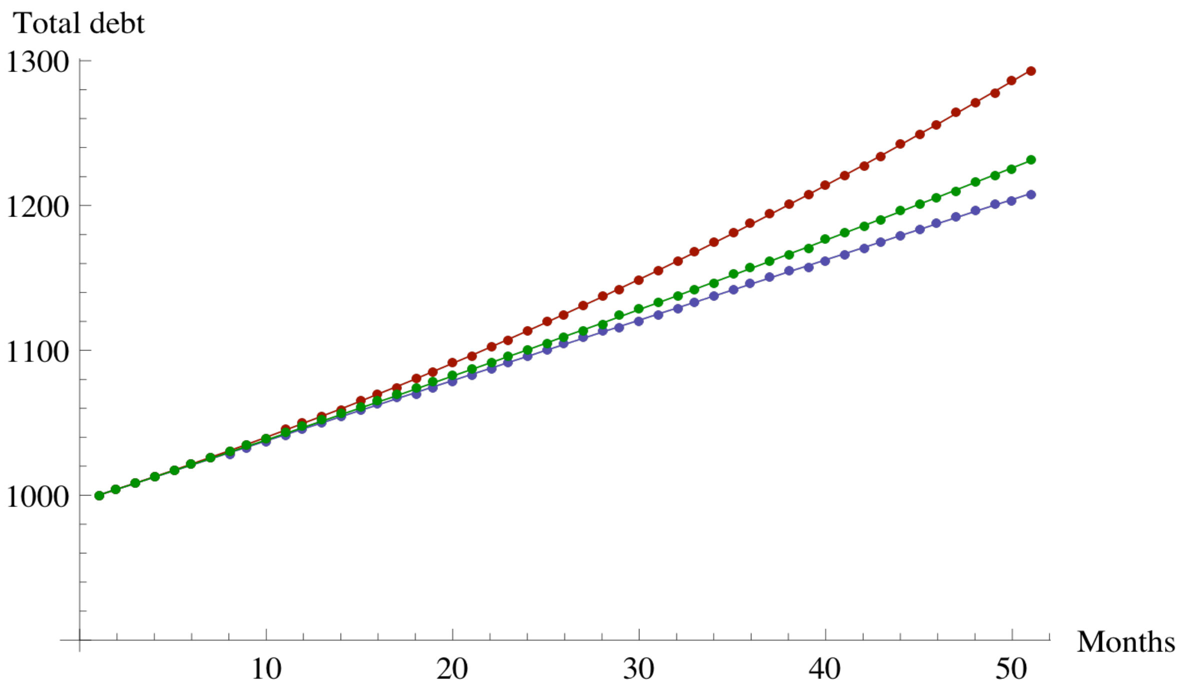

Fig. 5 Simple, Compound Interest, Simple + Penalty

The results shown in Fig. 5 could seem surprising, since the exponential series (in green), seems to have a slower growth than the quadratic one (in red). This however is true only in the short term, and given the interest rates used for this simulation. But as time goes by, the exponential series trend approaches the quadratic eventually reaching it and then overtaking it. This can be seen in the following longer-term simulation.

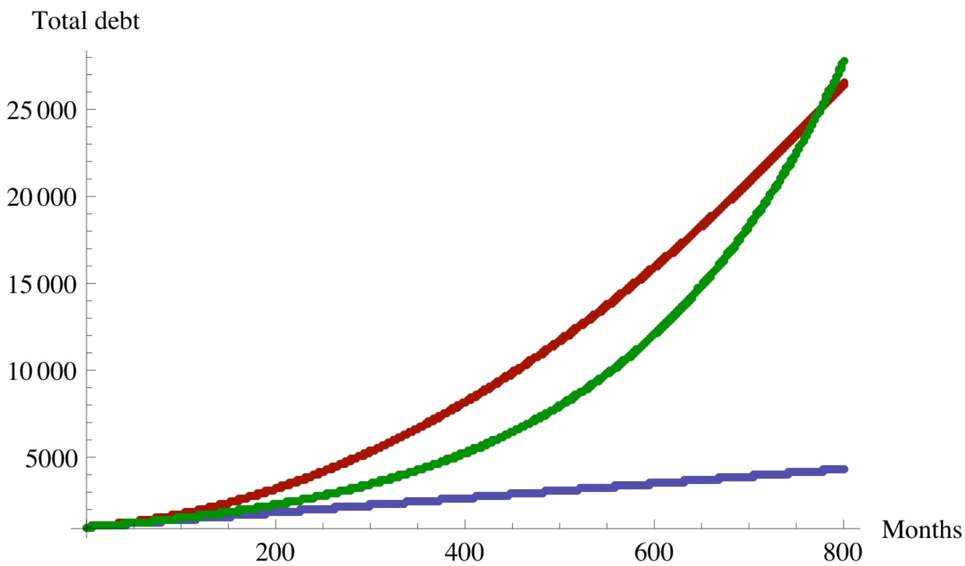

Fig. 6 Long-term comparisons Linear, Quadratic and Exponential

This simulation shows that, for the long term, compound interest carries a faster rate of debt growth

Refinancing introduces compound interest into the system

In this case it can be shown that refinancing a simple interest debt is equivalent, on the long term, to introducing compound interest into the system. The reason is quite clear: each time a debt is refinanced, all unpaid interest become part of the new principal and gives rise to regular interest on top of old interest. This is the exact definition of compound interest.

3. BROADER IMPLICATIONS AND OVERALL CURRENCY STABILITY

Given that interest in any of its commonly known modalities and according to control systems theory, introduces instability, it is important to further analyse the implications of such instability in the context of how the overall financial system operates.

Given the basic operation of the financial system as described below and assuming in the best case scenario that all loans are simple interest it will be possible to show that the prevalent financial system's design is inherently unstable as a whole because it has a bounded (finite) input in the form of pledged wealth but has an unbounded debt output. That is to say, the system will always by design produce excess debt that implies that either it ceases to operate or must refinance past debt in subsequent cycles. Therefore, since money creation and lending at interest is at the heart of the system, interest bearing loans represent an instability that is not compensated for within the design of the system itself and therefore must be absorbed by the greater economy. However, because the total aggregate interest applied has a specific value and represents a dynamic process, eliminating the subsequent instability introduced into the system requires an exact minimum compensation or its removal. The following diagram illustrates the general functioning of the current interest based fiat[12] money system:

[12] Fiat refers to money created by decree i.e. not based on a particular commodity such as gold, silver etc. It is important to note that this does not imply that the money has no real value backing it on the contrary and particularly the prevalent system the money is literally backed by all and any pledged wealth.

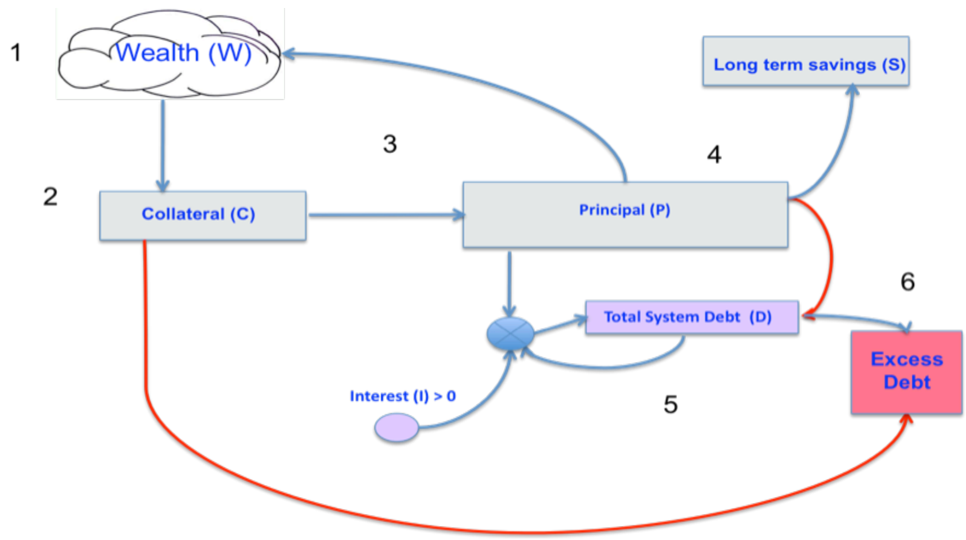

Fig. 6 Financial System Model[13]

1. Production of $\mathbf{W_{(k)}}$ is the result of a fixed spending of previously created $\mathbf{P_{(k-1)}}$ so that the ratio $\mathbf{W_{(k)}}$: $\mathbf{P_{(k-1)}}$ is constant such that,

$$1. \quad W_k \propto P_{(k-1)}$$

2. Fixed quantities of $\mathbf{W_{(k)}}$ are uniquely identified and correspondingly evaluated as a fixed value of units $\mathbf{C_{(k)}}$ for the purpose of loan security and therefore the ratio $\mathbf{W_{(k)}}$:$\mathbf{C_{(k)}}$ is also constant and,

$$2. \quad C_k \propto W_{(k)}$$

3. $\mathbf{C_{(k)}}$ (collateral) represents a fixed portion of $\mathbf{W_{(k)}}$ against which new $\mathbf{P_{(k)}}$ is issued as a fixed constant sum. Note, banking institutions are required to maintain a fixed ratio of $\mathbf{P_{(k)}}$:$\mathbf{C_{(k)}}$ sufficient to guaranty $\mathbf{P_{(k+n)}}$, therefore the ratio is required to be constant and,

$$3. \quad P_k \propto C_{(k)}$$

4. The amount **P** is entered as positive entries into users' accounts and as negative entries in liability accounts such that when $\mathbf{P_{(k)}}$ is subtracted from the users' accounts to completely cancel the negative entries in liability accounts, total $\mathbf{P_{(k)}} = \mathbf{0}$, i.e. effectively removed from circulation. Thus, $\mathbf{P_{(k)}}$ represents the total available money in circulation. Note that **S** also temporarily removes portions of **P** from circulation.

5. Total outstanding $\mathbf{D_{(k)}}$ is an unbounded sum of $\mathbf{P_{(k)}} + \mathbf{I_{(k)}}$ so when the system refinances $\mathbf{D_{(k-1)}}$, outstanding $\mathbf{I_{(k-1)}}$ is compounded with $\mathbf{I_{(k)}}$ and as shown above, growth of **D** becomes exponential.

The input of the system $\mathbf{W_{(k)}}$ represented by collateral is a fixed (bounded) sum $\mathbf{C_{(k)}}$ and the output (debt) is the unbounded sum $\mathbf{D_{(k)}}$.

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[13] All variables are expressed in the same monetary units

As a consequence and since $\mathbf{D_{(k)}}$ represents an unbounded demand on $\mathbf{P_{(k)}}$ then $\mathbf{P_{(k)}}$ is made perpetually scarce[14] and only quantities of new interest free **P** can compensate for the deficit.

Since $\mathbf{P_{(K)}} < \mathbf{D_{(k)}}$ and in the event that $\mathbf{W_{(k)} = W_{(k+1)}}$ and therefore $\mathbf{C_{(k)} = C_{(k+1)}}$ also (i.e. the same wealth is reused as collateral), then in order for $\mathbf{D_{(k)} - P_{(k)} = I_{(k)}}$ to be paid in the next period the following must hold:

$$4.\ \mathbf{P_{(k+1)} \geq I_{(k)} + C_{(k)}}$$

Hence when $\mathbf{W_{(k)}}$ is a constant quantity over successive periods, the ratio $\mathbf{W_{(k)}:C_{(k+1)}}$ should remain constant. But, for the system to continue functioning (see proportion 4) $\mathbf{P_{(k)}}$ must always increase over successive periods which implies that $\mathbf{W_{(k)}:C_{(k+1)}}$ cannot remain constant! Therefore, for $\mathbf{W_{(k)}:C_{(k+1)}}$ to remain constant $\mathbf{W_{(k)}}$ must increase always at least as a function of $\mathbf{I_{(k)}}$ or proportion 4 cannot hold and the system fails. The only other option is that the ratio $\mathbf{W_{(k)}:C_{(k+1)}}$ decreases as a function of $\mathbf{I_{(k)}}$ giving way to inflation.

4. CONCLUSIONS

Interest, according to control system theory in all its modalities (simple and compound) represents a point of instability in the system. When refinancing of past debt takes place, simple interest becomes compound and the instability produces an unbounded exponential output of debt.

The instability has systemic repercussions in that the constant ratios required by the system cannot be maintained without a constant growth in wealth production in proportion to the system's exponential debt growth output or and in order to stave off collapse, the system must introduce new debt money without any corresponding new wealth thus producing inflation.

Thus the value of the currency unit is systematically undermined whenever the system fails to provide sufficient new wealth to back passed excess debt not only because of the system's internal accounting but more importantly because the users directly perceive excess debt as a cost and build that cost into all their operations.

Because of the true complexity of industrial and economic processes it is impossible to reduce an economy's global wealth output to a centrally determined interest rate as a means of control. Furthermore, there is a constant resistance to submitting free hold wealth as collateral for loans. Therefore it is inevitable that the system will fail in consistently providing on schedule the amount of wealth needed for refinancing residual past debt that otherwise

[14] The flows between points in the system where sums are insufficient for any period (k) to satisfy related demands are illustrated with red arrows, while the blue arrows represent sufficient flows.

would remain without the requisite wealth backing. Thus interest is a constant source of inflation.

Another important and more spectacular case where inflation becomes very rapid is when all the most valuable wealth available is locked up in debt contracts such that a debt saturation point is reached. This saturation point coincides with the point of minimum capability of bringing new wealth (as most is already being used as collateral), maximum overall debt and therefore the point where the economy has the highest potential for producing excess debt and hence demand for new wealth! It is at this moment when the economy becomes forced into either total collapse or what is colloquially called run away inflation. One of the symptoms of these last days that indicates we are in such a situation is the practice of using as collateral for the creation of new debt money, collections of entire debts packaged as "funds" that neither have any conclusive wealth backing and that even more alarmingly no one has the means to calculate or keep track of the growth of that debt.

Finally, one of the properties of a system run on these Common Lending Practices is that overall system stability is entirely precluded. Translating this to layman terms, there is no possibility of maintaining equilibrium for any period of time. The economy either continues to force growth of either wealth or inflation, or the system is destroyed. Furthermore, it is important to note that although BIBO is strictly speaking a criteria for stability of Common Lending Processes it is not sufficient for currency systems not to have a perturbing effect on economic activity as a decreasing or withering interest rate would also be BIBO (i.e. provide a bounded output) but would nonetheless continue to generate inflation that can certainly be a cause of destabilisation of economic activity that are affected by the use of currency. Therefore, it is equally required that the system be passive or inert (Note: stability is a requirement for passivity).

Given the state of the world's finances and that empirical observation appears to corroborate the hypothesis supported (is it not the case that the market is being flooded with liquidity against debt with no wealth backing?). It is imperative that interest as applied in Common Lending Practices, now an identified root cause of instability, be removed. Removal of interest also is necessary to eliminate inflation as a function of design that can adversely affect real physical economic processes. Since the money system is purely a logical design, eliminating interest can be achieved instantaneously by mere volition without any adverse effects. Note that loss of interest income is compensated by elimination of inflation.   Bank administrators can continue to be remunerated for their otherwise valuable services by a flat service charge in lieu of interest as a function of time as follows:

x % P is taken from **P** to pay employees and other operating costs such that at all times **D = P**.

No other solution exists for the present crisis to guaranty both stability in the currency, eliminate system design generated inflation and prevent the system from complete irreversible collapse the threat of which has come about due to hyper reduction of the ratio of **W** with respect to **C** (i.e. inflation) and as shown above, a direct consequence of **I.**

References:

- LETS Engineering Bank Math, by John C. Turmel, B. Eng.
- MODERN MONEY MECHANICS, A Workbook on Bank Reserves and Deposit Expansion, Federal Reserve Bank of Chicago, P. O. Box 834, Chicago, IL 60690-0834

ANNEX I

Experiment Design for Testing the Hypothesis from:“Formal Stability Analysis of Common Lending Practices and Consequences of Chronic Currency Devaluation”

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Introduction

If one wishers to perform an experiment to prove the conclusions of the document “Formal Stability Analysis of Common Lending Practices and Consequences of Chronic Currency Devaluation” , herein we provide a design that can be undertaken anywhere. The document includes all of the pertinent data true to the present system operation to conclude in the best possible conditions the instability. For example, savings are not included as including them would withdraw even more money from circulation augmenting the systemic deficit of liquidity required to satisfy debt growth.

Hypothesis

No matter the nature of wealth traded in an economy or the relative success or failure of economic activity or the nature or behaviour of the participants, “Common Lending Practices” as described in the formal stability analysis will always exhibit unbounded outputs in the form of residual interest bearing debt beyond the bounded value attributed to discreet and finite wealth and beyond the sum of money created in the form of the principal sum of loans.

Experimental Method

Participants and Materials:

- n players including at least one that acts as a banker.
- note pads, pencils or any other recording means
- coins or any other random device
- A clock and alarm

Methods

All wealth, contracts and transactions are represented/recorded on paper using note pads and pencils as follows:

Representation of wealth

A written deed or title is used as collateral in loan contracts as well as in transactions. When new money is issued as a loan, the deed is written by the borrower and held by the Bank. Similarly, when a player undertakes to sell, the deed is what is passed to the buyer upon completion of the transaction. Thus, any wealth can be represented as unique and unequivocal articles e.g. house, tool, vehicle, medical examination, music lesson etc.

Transactions

Any wealth to be transacted is represented by writing on a sheet of paper:

- Descriptive name of the article of wealth and unique id of that wealth
- Unique identification of the provider of the wealth

Wealth title/deed:

Table 1 Title/Deed		
Wealth	**Wealth ID**	**Provider ID**
A house	00001	John Doe

When the wealth is transacted, each participant records on a separate transaction sheet:

- The id of the counter participant to the transaction
- The id of the wealth transacted
- If the participant is the buyer of wealth the participant records the stipulated price as a negative sum under the “Bought” column.
- Note that in the case of a loan credit the amount is added to the balance and loan payments are subtracted from the balance.
- If the participant is the buyer of wealth the participant records the stipulated price as a positive sum under the “Sold” column
- A running balance is maintained in brackets if negative

Table 2 John Doe’s transactions					
Participant	**Amount**	**Article of Wealth**	**Bought**	**Sold**	**Balance**
Bank X	10,000	Loan			10,000

		credit ID			
John Smith	5,000	Car	(5,000)		5,000

Money Creation

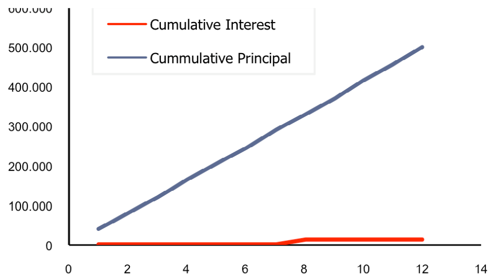
Each player is issued in the form of a loan a quantity of new money proportional to the value of the wealth pledged by each and stipulated by the Bank to have a value C. The bank then issues to the participant an amount of money P, interest rate r and n periods where:

- P < or = C
- Periods are all of equal duration
- The loan contract expires at the end of period n
- r is a percentage of P

Thus, for each participant the Bank maintains the following sheet:

Participant ID: John Doe
Colateral: Deed/Title ID: 500,000

Prinicpal Amount (**pv**)	$500,000
Interest Rate (**rate**)	0.42%
Total # of Periods (**Nper**)	12
Payment per Period	**$42,803.74**
Total Interest Paid	**$ 13,644.89**
Total Debt	**513,644.89**



Period	Payment Amount	Interest	Cumulative Interest	Principal	Cummulative Principal	Balance Loan 1	Deficit Loan 1
						$ 500,000.00	
1	42,803.74	2,083.33	2,083.33	40,720.41	40,720.41	459,279.59	457,196.26
2	42,803.74	1,913.66	3,997.00	40,890.08	81,610.48	418,389.52	416,475.85
3	42,803.74	1,743.29	5,740.29	41,060.45	122,670.93	377,329.07	375,585.78
4	42,803.74	1,572.20	7,312.49	41,231.54	163,902.47	336,097.53	334,525.32
5	42,803.74	1,400.41	8,712.90	41,403.33	205,305.81	294,694.19	293,293.79
6	42,803.74	1,227.89	9,940.79	41,575.85	246,881.65	253,118.35	251,890.45
7	42,803.74	1,054.66	10,995.45	41,749.08	288,630.74	211,369.26	210,314.60
8	42,803.74	880.71	11,876.16	41,923.04	330,553.77	169,446.23	168,565.52
9	42,803.74	706.03	12,582.18	42,097.71	372,651.49	127,348.51	126,642.49
10	42,803.74	530.62	13,112.80	42,273.12	414,924.61	85,075.39	84,544.77
11	42,803.74	354.48	13,467.28	42,449.26	457,373.87	42,626.13	42,271.65
12	42,803.74	177.61	13,644.89	42,626.13	500,000.00	0.00	-177.61

Figure 1.[15]

[15] Note that the deficit shown is less than the total amount of interest charged as interest payments are not withdrawn from circulation while principal is and Banks may spend back any amount of interest income including all of it. Nonetheless and in spite of this a deficit is inevitable and 100% of re-spending does not occur in practice as Banks use their income to pay savings for example.

And the bank will also maintain the following table:

Table 3 Running Sums of Principal, Debt and Collateral Value		
Outstanding Deeds (running sum of value remaining as collateral)	**Outstanding Principal (sum of money in circulation)** (total principal issued – principal payments)	**Outstanding Debt** (penalties + total (P + I) – total periodic payments realized (see figure 1)

Simulation of Economic Activity

To represent wealth in transactions and as loan collateral each wealth used will be represented as a Title/Deed using the table 1 above. A coin will be used (or any other random device) to emulate the effect of market outcomes i.e. to determine which of any proposed transaction takes place. The experimental setup is as follows:

1. Each of n players pledges wealth with the bank using a unique Title/Deed
2. The bank creates a loan sheet (see figure 1 above for details).
3. Every amount of P paid cancels that amount such that when 100 % of principal issued is paid effectively 100% of that money is removed from circulation.
4. Total debt is the sum of all periodic payments of (Principal/n periods) * (annual interest/12) + Penalties.

A: Each participant including the bank (spending interest income) in round robin fashion competes with every other participant to determine which will sell and which will buy. Note that the bank can only buy from others as the banks "sales" are the actual loans and the interest payments are not withdrawn from circulation and thus can be spent back.
B: Outcome of "economic activity" is achieved by each in each round robin pair establishing a price for a given wealth (see table 1 above) they wish to sell in that round robin encounter.
C: Flipping of a coin is used to determine which of the two participants in each encounter sells to the other.
D: The player that wins the coin flip is the one that sells and the other must pay the amount established if and only if he has sufficient units to meet the price. If such is not the case i.e. the player does not have sufficient units, the transaction is cancelled.
E: Each participant then forms the next round robin pair with the next corresponding participant and repeats the buying selling simulation.
F: Round robin tournaments are repeated until each of all the players either fail to meet their payments altogether or have paid their loans off.
G: At each loan payment period each participant is required to pay the amount stipulated in the loan agreement (figure 1) to the bank, if a player cannot pay he becomes liable to pay that amount + a late payment charge added to the next

payment due at in the subsequent period.
H: Participants can cancel the total of their outstanding debt at any time.
I: At the end of the term of a participant's loan, the participant must have satisfied all of the planned payments or lose the corresponding pledged wealth to the bank.
J: Debts not satisfied at full term continue to increase by penalty amounts

Results

The following final aggregate data is required to test the hypothesis (see above) at the end of the last period of the last loan:

1) Outstanding P
2) Outstanding Debt
3) Value of Outstanding Collateral not freed from liens.

The hypothesis claims that the results will necessarily be:

1) Outstanding P < Outstanding debt (an unbounded sum)
2) Initial value of outstanding collateral will be directly proportional to outstanding P but not to outstanding Debt.

According to the BIBO definition of stability the unbounded value of 1) proves that the system lending practices are unstable by definition.