Not In Your Best Interest: Where Our Central Banking System Fails Us and What We Can Do About It

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May 15, 2024

Contents

1 Core System

1.1 Introduction

The core function of a Central Bank is money creation. This system proposes a mechanism to do this that avoids the need for active institutions. A system for Government revenue and spending is not discussed in this section, but will be discussed in the full system.

Our proposal for the Central Banking system is simple and light-touch.

1. Every individual in the economy receives a Universal Basic Income, u.
2. Stability of the money supply is achieved through a savings fee, f_s, which is applied directly to all money (savings) in the economy.

This results in the total money supply, T, having a well-defined and stable level (see appendix **??** for derivation):

$$T = \frac{Nu}{f_s} \tag{1}$$

Where N is the population size.

1.2 Money Supply Control

Equation 1 we provides mechanisms to direct control the money supply through the savings fee, f_s, and the Universal Basic Income (UBI), u.

We suggest that the savings fee, f_s, and the UBI, u, should be adjusted infrequently, in response to economic conditions, or predictably, if there are benefits of consistent growth or decline of the money supply.

1.3 Savings Fee

The savings fee, f_s, is a fee applied to all money in the economy. One effect of the savings fee is on the money supply, as shown in Equation 1.

Additional effects of the savings fee can be interpreted from a systems perspective, where it acts as an exponential decay filter. This interpretation is valid at all levels of the economy as the savings fee mechanism is applied uniformly throughout the economy, independent of the scale of the transaction.

We can write the savings fee as:

$$f_s = 1 - e^{\frac{-t}{\tau}} \tag{2}$$

Where t is the period at which the savings fee is applied (in units of time), and τ is the time constant of the savings fee (in units of time). The time constant τ is simply nice way to parameterise the savings fee [1], and we will use this throughout the paper.

Any period, t, could be used however we suggest that the period be set to a day and use this as our representative time unit. This balances concerns with coarse application, such as a year, where

[1] This parameterisation is common when discussing first order filters (systems), which we demonstrate our core system is in the appendix **??**.

the economic activity will price in the savings fee and cause distortions in behaviour throughout the year (period), and finer application, such as an hour, where people would be penalised for sleeping.

The decision to use a day could be seen as adhering to a day being a natural rhythm (or clock cycle) for people, and therefore, a natural rhythm for the economy.

The time constant, τ, is a parameter that can be adjusted to control the rate of decay of the savings fee. A smaller τ will result in a faster decay of the savings fee, and a larger τ will result in a slower decay of the savings fee.

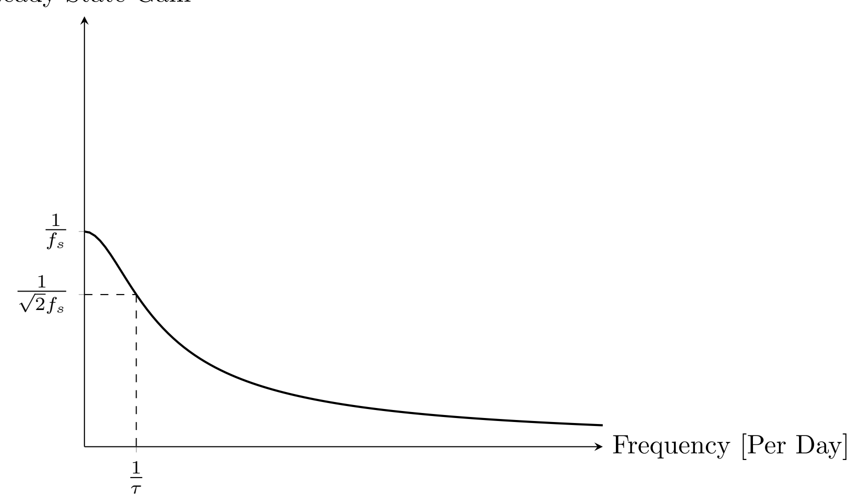


Figure 1: Frequency Response of Savings Fee.

The figure above is the graphical representation of the frequency response of the savings fee, interpreted as a first-order low-pass filter.

We note that the time constant, τ, is the cut-off frequency of the savings fee filter. As will be shown in our section on Sustainability and The Fire Economy **??**, (some) economic activities occuring at a frequency higher than the cut-off frequency will effectively be attenuated by the savings fee. Our initial suggestion for the time constant would be around a year, as this balances the benefits of attenuation of high-frequency economic activity (discussed in the section on the Fire Economy) without penalising seasonal economic activity.

If practice, this parameter could of course be further tuned.

For the remainder of this paper, we will assume that the savings fee is applied daily and, if not stated otherwise, the time constant is set to one year.

We do not consider the savings fee to be a tax, as it forms a core part of the money creation mechanism; the savings fee is not used to fund government (or other institutional) spending.

We prefer the interpretation that the savings fee and UBI combine as part of a conservation theory of money, and the savings fee motivates the circulation of money in the economy.

As the savings fee might still feel like a tax to some, we provide the following table to show the effective tax rate (fee applied).

$$\epsilon(k) = 1 - (1 - f_s)^k = 1 - e^{\frac{-k}{\tau}} \tag{3}$$

Where k is the number of days the money is held, and τ is the savings fee time constant in days.

Days	Effective Tax Rate (%)
0	0
1	0.274
7	1.90
30	7.89
180	38.9
365	63.2

Table 1: Effective Tax Rate for Different Saving Periods

We note that the effective tax rate is now independent of income, but is instead a function of the number of days your money is held and the savings fee. This is in contrast to the current system where the tax rate is a function of income.

An immediate consequence of the savings fee is that it will discourage the hoarding of money, as the savings fee will be applied to all money held. This will encourage spending and investment, as the savings fee will be applied to all money held, regardless of whether it is spent or not.

Although this structure is progressive, as the fee paid is linear in savings, it does not directly prefer the rich or the poor. It is more likely that rich individuals will have more savings, and therefore pay more in fees, but this is not a direct consequence of the fee structure. If rich individuals can better spend or invest their money than people poorer than them, they will pay less in fees than people poorer than them. For this to be fair, there must be good opportunities for all individuals to spend or invest their money.

We believe that this system is fair as individuals should better able to make their own decisions with knowledge of their circumstances and preferences, rather than having a system that favours one group over another.

There is one unanswered question that remains: if everyone wants to spend, who will accept the money? People will demand money when they know they can spend it, and people will then accept money when they know they can spend it. This highlights that this core system is built on the trust that the money you receive in exchange for providing value will be accepted by others in exchange for value; money functions as a medium of exchange and is like an IOU system for the whole economy.

The concern here is whether there will always be enough value to exchange for money. If there is panic that money will not be accepted, this could cause a situation where money is no longer accepted and the economy collapses. The failure mode in this case is interesting, everyone would (asymptotically) reach the same amount of money (level of spending power), so the economy would have effectively reset. In this case, people could start exchanging value for money again and the economy would start to grow, without the need for bailouts or stimulus packages.

This is in contrast to the current system where people hoard both money and goods, and the economy collapses due to a lack of money; a reset is formed of bailouts, stimulus packages and printing more money, leading to catastrophic hyperinflation. A stable reset that avoids hyperinflation is a key benefit of this core system.

Although the failure mode for our system is better, this still does not tackle the core concern that there might not be enough demand for money. The core system does not address this, however, we do address additional structures in the full system that will help to ensure that there is always demand for money.

1.4 Universal Basic Income

Our proposal for a Universal Basic Income (UBI) is that every individual in the economy receives a guaranteed income, u, at regular intervals. This income is not means-tested, and is not conditional on any other factors. Some may argue that this is “paying people to do nothing”, however, we believe this argument neglects that they too (everyone) could receive the UBI and do nothing. The UBI is a fundamental part of our money creation mechanism, and is not a welfare payment; if there is not enough produced in the economy, the UBI will not be enough to live on.

In healthy economies, the UBI will function like a welfare payment and could be enough to live on, but it is not a guarantee. The secondary effects of the UBI will be discussed later in the context of the full system, as the full system contains additional structures and political considerations. The core system is designed to be as simple as possible and, as it is only concerned with the mechanics of money conservation, mostly apolitical.

We suggest that the interval at which the UBI is paid is the same as the period of the savings fee, t. These two could be decoupled, but having the same frequency should be smoother for money creation, and therefore the economy. This follows from applying similar arguments that motivate a daily savings fee to the UBI.

1.5 Democratic Money Creation and Spending Power

The core system we propose through UBI payments and the savings fee forms an independent and democratic mechanism for money creation. If the Central Bank makes no adjustments to the UBI or savings fee, this core system will continue to operate indefinitely.

This is in contrast to the current system where Commercial Banks are the primary source of money creation [1] and the Central Bank has to actively intervene to achieve its monetary policy goals. This highlights both the fragility of the current system and the lack of democratic control over money creation.

We define the daily spending power of everyone's UBI, S, as:

$$S = \frac{Nu}{T} = f_s \tag{4}$$

This is the total UBI payments, Nu, divided by the money supply, T. From Equation 1 we can see that the daily spending power of the UBI is equal to the savings fee.

As all money in the economy traces back to the UBI, we can generalise this result to arbitrary periods. The total spending power of the economy in a window of k previous periods (inclusive), $S(k)$, is then given by:

$$S(k) = \left(\frac{Nu(1-(1-f_s)^k)}{f_s}\right)\left(\frac{1}{T}\right) = 1 - e^{\frac{-k}{\tau}} \tag{5}$$

Which is the same as the effective tax rate, $\epsilon(k)$, as defined in Equation 3. This result demonstrates how the tax on savings facilitates democratic spending power in the economy.

In tabular form the effective spending power of the UBI is:

Days	Normalised Time	Effective Spending Power (%)
1	$\frac{\tau}{365}$	0.274
7	$\frac{7\tau}{365}$	1.90
30	$\frac{30\tau}{365}$	7.89
180	$\frac{\tau}{2}$	38.9
365	τ	63.2
∞	∞	100

Table 2: Effective Tax Rate for Different Saving Periods

For a time constant of $\tau = 365$ days, we see that there is little immediate effect, but over time the effective spending power of the UBI grows to 100 percent. If the time constant is reduced, the daily spending power will be higher (greater f_s) and the effective spending power will increase faster too. This is supported by interpreting the savings fee acts as an exponential moving average of previous UBI spending, so a greater savings fee (time constant) will weight more recent UBI spending more heavily. A higher savings fee will result in an economy that is more sensitive to changes in daily spending, and therefore might be more dynamic, but this must be balanced by the potential penalty on seasonal economic activity (as discussed earlier).

The effective spending power is an aggregate measure of time averaged UBI spending. This does not mean that individuals spending power is necessarily dependent on the savings fee, their spending power is mostly determined by their income. We will introduce the concept of spending levels in the economy to discuss this further.

The spending levels in the economy, $\sigma(n)$, for a given population slice, n, are given by:

$$\sigma(n) = \left(\frac{N}{n}\right)\left(\frac{u}{f_s}\right) \quad 1 \leq n \leq N \tag{6}$$

This equation is an upper bound for the number of people, n, that can spend at a given level, $\sigma(n)$. When $n = N$ this is the maximum spending power of the UBI, u, demonstrating it is the foundational level of spending within the economy, and any goods or services priced at higher than $\frac{u}{f_s}$ will never be accessible to everyone.

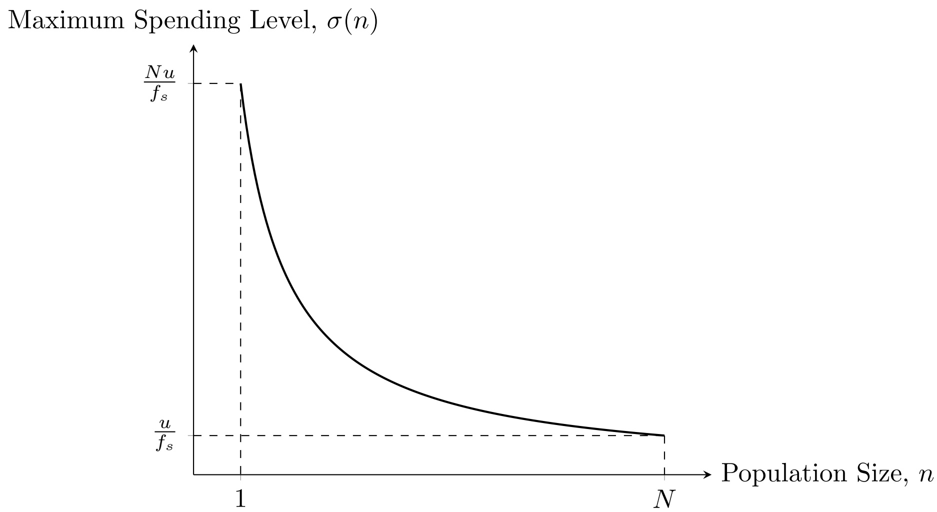


Figure 2: Maximum spending level, $\sigma(n)$, for a given population slice, n.

Graphically, this is shown in Figure 2. From this figure, we can see that the most accessible level of spending is for goods and services priced at less than or equal to $\frac{u}{f_s}$ and that the number of people that can access goods and services at a given price decreases as the price increases above this. The highest level anyone can reach is $\frac{Nu}{f_s}$, which is the case for someone who earns everyone's UBI and saves all of it (forever).

While the spending levels are related to the savings fee, f_s, ultimately they are accessed by earning an income. This income is ultimately sourced by doing work that is valued by others, and therefore, these spending levels are a reflection of the value that people provide to the economy. If the savings fee was 100%, then the spending levels would be equal to your income, and you would only be able to consume at a level of the UBI, plus any work you did that day. In a system with a 100% savings fee, there is no memory of past value provided, so the work you did yesterday is forgotten and not valued today.

With an intermediate savings fee, like we propose, higher spending levels can still be reached as you can accumulate spending power through saving. There is a limit to this, and the savings fee will determine the maximum spending level that can be reached by an individual at a specific savings rate (unspent income) as well as how fast this is reached. In the case of a 100% savings fee, the maximum spending level is reached immediately, and for a savings fee of 0%, the maximum spending level is unbounded, but physically constrained by how long you live. For a savings fee with time constant of a year, your savings will reach 63.2% of your maximum spending level in a year, and 99.9% in just under seven years; due to the nature of the savings fee, there will be diminishing returns on saving, and the maximum spending level will be reached asymptotically (never quite reached).

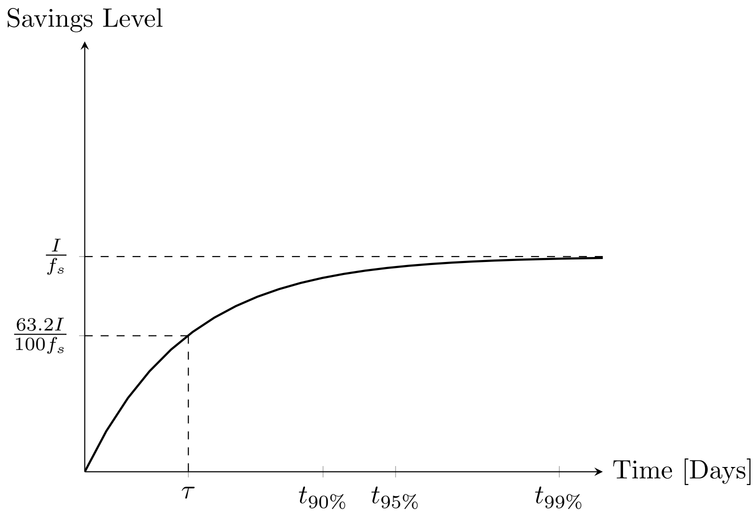


Figure 3: Returns against time for practical savings fee structures; f_s is the savings fee.

Above is a graphical representation of the diminishing returns on saving for a person with income, I. We recognise this as a first-order system response, and that the increase in savings monotonically increasing, but at a decreasing rate (the function is concave).

Examining the other extreme when the savings fee is 0%, work from thousands of years ago would be valued the same as work done yesterday. Even if the work that was done is no longer valued by anyone alive today, it can remain as an almost zombie value in the economy. In reality it is more difficult to place an exact measure on the prevalance of how old activity (old money) shapes the current economy, as the effect of interest payments (risk-free returns) keeps this money alive while inflation (and a growing money supply) effectively destroys it. However, some dead value is kept alive today, for example in 2015 the UK had only just finished paying off debts from as far back as the 18th century, which were used to fund the Napoloenic and Crimean wars as well as the Slavery Abolition Act (1833) [2].

The initial payment for the Savings Abolition Act loan (1835) was twenty-million pounds. Calculating the spending power of this money in today's economy is difficult, because it depends on the specifics of the interest and principal payments, but as the total sum for all the historical debt (including payments for Napoloenic and Crimean wars) was three-hundred and eighty-two million [2], it is clear that it is not zero. In our system, with a savings time constant of a year, the absolute value of the initial loan would have been:

$$2010^6 e^{\frac{-365(2015-1835)}{365}} = 1.3410^{-71} \approx 0 \tag{7}$$

Which means the spending power would be zero. This is a clear demonstration of the difference in our system, things are valued based on those who are alive today, in the current economy, rather than zombies of the past.

We recognise the exact nature of the payments for something like the Slavery Abolition Act (1833) could be different in our system, but so long as the payments are finite the result will be the same. This highlights a difference in the way a Government could borrow in our system, although Government borrowing will not be integral to either our prosal for the core or full system.

A key result of our spending levels analysis is that the number of people who can access goods and services will tend to decrease as prices increase. This is not strictly different from the current system, it is more explicit in our core system.

In the current system, borrowing (and interest payments) requires growth of the supply grows. This means the accessibility of goods and services at given price levels is dependent on not just variation in individuals income and how long they save, as in our core system, but also variation in the growth of individuals' income and savings. If everyone's income and savings grew at the same rate as the money supply, the effect in the current system would be the same as our system with a 0% savings fee (no stabilising mechanism for the money supply). This is not always the case, as some people will have enough disposable income to benefit from the risk-free rate granted by Government bonds (gilts) while poorer individuals (who are less liquid) will not. This can lead to inequality in the accessibility of goods and services when the risk-free growth of savings is greater than the growth of income. Overall, this is a criticism on unearned income, which is systemic in the current system, and we treat returns from investment separately and will expand on this further on our section on 'Borrowing and Debt' 2.3.

Finally, we note that the limit on wealth is the total money supply, T. For a fixed savings fee and UBI, this grows linearly with the population. Therefore, the limit on absolute wealth is dependent on the population size, but the limit on spending power in all cases is the same and equal to one. This is a key result in demonstrating that our system is not preventing people from becoming wealthy, but our system indeed does incentivise lower levels of inequality.

1.6 Role of the Central Bank

While we have provided mechanisms for the Central Bank to control the money supply, to potentially respond to economic conditions, we have not discussed the primary role of the Central Bank in the economy.

The primary role of the Central Bank in the core system is administrative. The Central Bank is responsible for the distribution of the UBI and the application of the savings fee. The Central Bank will have little to no involvement during healthy economic conditions, as the core system will operate independently.

Additional administrative functions may be required to facilitate international trade through foreign exchange mechanisms, but we are also aiming for these to not require active involvement from the Central Bank. How this could be achieved will be discussed in the full system.

1.7 Inflation

As our system has a stable money supply, we cannot support core inflation. To support core inflation you require a growing money supply, while this is still possible in our system, we are not looking to propose this in our full system as we do not see the benefits of core inflation in the presence of a savings fee.

This is not to say that supply or demand side 'inflation' does not occur. A fixed money supply can still support variation in the prices of specific goods and services, as a result of changing consumer preferences (demand), but increasing prices cannot occur across the whole economy; similarly, prices can vary due to changing supply constraints.

Core inflation is often a target for Central Banks, the argument from the Bank of England against low (or negative) core inflation is that this can discourage spending as people wait for prices to fall [3]. We eliminate concerns of decreasing prices (deflation) through the savings fee, which will always encourage spending, and therefore the need for core inflation.

Additionally, we note the way the current system achieves its core inflation targets has led to the need for active measures such as quantitative easing [4].

Overall, the light-touch approach of the core system and its ability to better achieve the goals of current Central Banks shows the favourability of our proposed system.

2 Full System

This section will provide the additional structures we believe are beneficial to a model full system. This includes the basic framework for Government spending and a mechanism for increasing demand for money, as well as discussions on mechanisms for foreign exchange.

2.1 Demand for Money

2.1.1 Introduction

In this section we propose a solution to insufficient demand for money in the core system. Previously, we identified a potential problem of people potentially storing their wealth in assets like land and how this risks economic collapse, albeit with a safer failure mode.

Our proposal also addresses concerns people may have for the need to save for housing [2].

The proposal itself is a new system for land and property rights distribution that will neither require saving for a house nor promote hoarding wealth in land. Instead daily payments will be made to renew land property rights, with the money used to fund the Social Contract; land 'ownership' will be a liability to those who get no value from it, discouraging hoarding and promoting use - we see this as a more efficient use of land.

Recognising that there is always a need for land in our society, we see this as a good opportunity to boost the demand for money. This supports a wider strategy that supports fair and effective democratic taxation. In the upcoming discussion on democratic taxation and government spending power, we will explore how government spending effectiveness and the intrinsic value of land for economic activities influence the demand for land.

Overall, our approach involves a reform of property rights and land ownership, with the government assuming ownership of all land and leasing it to individuals or broader economic entities. This strategy is designed to ensure consistent access to land over time and reduce inequality in access to land ownership.

We stress the primary aim of this reform is not to constrain the use of land but to establish a more effective and dynamic system for its allocation. By insulating the housing market from speculation and potential bubbles, we seek to foster greater stability within the housing market and, by extension, the overall economy. Furthermore, this reform is intended to facilitate a democratic process for taxation and government spending, enhancing the government's capacity to provide essential services and social welfare effectively.

2.1.2 Property Rights and Land Ownership

Property rights formalise the concept of ownership. They are a set of rules that determine who has the right to use, control, and transfer property. They also serve as the foundation for legal protection against the violation of these rights.

A country, as defined by its borders, is the land that a group of people have agreed to share. If these rules are not agreed upon, the land is not a country but a battleground. The collective agreement to respect the law of the land is what makes a country a country.

If all were free to do what they wanted with their land, what would stop your neighbour from building a factory next to your house? If the market was the ultimate decider, you would all have

[2] Our section on private lending discusses how the view that saving is necessary is not reflected in our system and is, therefore, a hangover from the current system that incentivises it.

to pay this person to stop; you would all have to be as productive as that factory to keep your home the way you like it.

In reality, what stops the factory from being built next to your house is your local council. Democracy puts a guardrail on the market, keeping it grounded and aware that we are people living in a society, not just cogs in a machine.

Be careful of those who try to tell you otherwise, because I guarantee they are not the ones who will be living next to the factory. It will be you and I, the everyday people, who are tricked into thinking freedom for them is freedom for us.

2.1.3 The Ladder Contract

The Ladder Contract is a new kind of contract that aims to better shape market incentives to align with the needs of society. It is a simple and interpretable contract that is best applied to capital goods, such as land (and therefore housing).

The initial contract is between the people and their democratically elected governments. In essence, people all own the land and lease this land (distribute) to members of society, with democratically elected governments acting as intermediaries who collect and distribute the revenue.

The basic details of the contract are as follows:

- The minimum term of the contract.
- The maximum term of the contract.
- The conditions of use.
- The conditions of transfer.
- The maximum contract payment.
- The market valuation mechanism.
- The use of the tax revenue

The contract would be renewed automatically upon daily payment; the minimum term of the contract is the period you commit to making payments for, and you can only leave the contract early by selling the contract to the market [3]; the maximum term is the longest period you can hold your rights before it expires or has to be renewed at market price (this depends on the nature of the contract and will be different for, say, land developers and home owners); the conditions of use would determine what you can do with the land; the conditions of transfer would transfer would dictate whether direct transfer of property rights (not through the market) is possible, in addition to how property rights can be split up (for example, to allow for renting); the market valuation mechanism would exist for transferable contracts and should be built on an open market where anyone can bid; the tax revenue should be applied the same universally, through the Social Contract, and is therefore 'negotiated' democratically through political structures.

[3] if the market price is lower than your contract payments, you will be liable for the difference

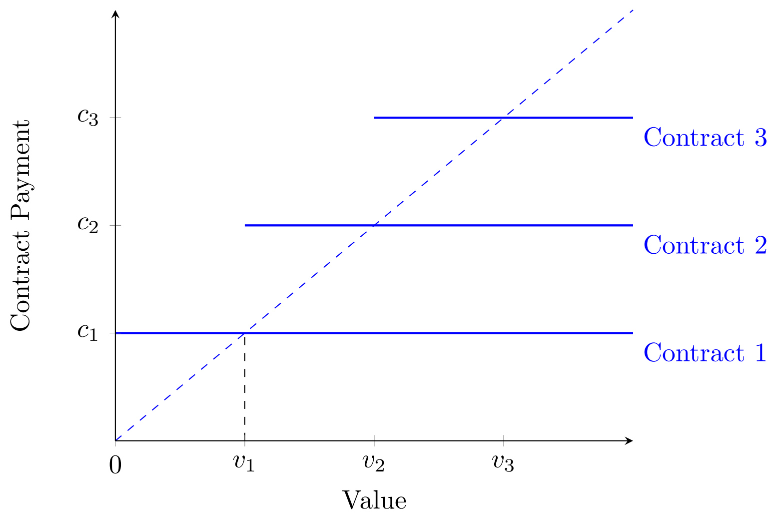


Figure 4: A visual representation of the Ladder Contract.

The figure above is a visual representation of a ladder contract with three rungs (parties). The horizontal axis represents the value of the land as perceived by the contract. The vertical axis represents the contract payment made by each rung. The figure shows how as the market value of the land increases this facilitates, but does not require, additional contracts.

Stakeholder Analysis

This section will discuss the stakeholders in the Ladder Contract and how they interact with each other. We will discuss how the rights and responsibilities should be shared between the stakeholders, and how making this explicit should allow for a fairer more robust system.

Figure 4 can represent a variety of different contracts. We will explore a case where: the bottom rung represents a land developer, the middle rung represents a building manager, and the top rung represents tenant(s). In this contract, each rung is a separate entity.

All payments in the contract are from the current tenant(s), so sum to c_3.

The Government receives a payment of c_1, which is the tax revenue from the land. This revenue is then used to fund the Social Contract, as discussed later. The Government will receive this payment for the duration of the contract. For land developers, we suggest that the contract is a fixed duration, such that the minimum and maximum length of the contract are the same. This is to ensure that the land developers are appropriately taking on the risk of the land and that they are incentivised to develop the land in a way that is beneficial to society.

The land developer receives a payment of $c_2 - c_1$, which represents the value they have added to the land. In this example, this is the building that they have built. They will receive this payment for the duration of the contract, so long as there are tenants in the building.

Finally, the building manager receives a payment of $c_3 - c_2$, which represents the value they add through providing a service to the tenant. They will receive this so long tenant(s) are in the building and their contract is still valid.

The Government cannot void the contract with the land developer, but it will automatically be void after the contract expires. When this happens the payments into the Social Contract will increase to the contract payment of the next rung (the building manager), this will mean that the tenant(s) are now paying c_2 into the Social Contract, and would remain paying $c_3 - c_2$ to the building manager.

For as long as the land developer's contract is valid, the land developer can provide whatever protections they wish to the building manager. This is because the land developer takes on the risk of the land, and so they are still incentivised to provide a good service to tenants. We hope a well-informed market will properly evaluate the services of these middlemen before entering into a contract.

Sandwich Contracts

Sandwich contracts are where the top and bottom rungs are the same entity, the middle rungs can be seen as an abstraction of the value added by services. In this case, the middle rungs are services that people choose to pay for.

Sandwich contracts are more complicated when you have multiple people living in a building. The property rights of the base contracts, if owned by just one individual, would be clear. However, if this base contract has freedoms that would affect the liberties of other tenants, this would be a problem. As the base contract, and the associated rights, are between individuals and Government, this would be akin to a planning permission issue.

2.2 Social Contract

2.2.1 Introduction

As the tax revenue for the Government is now determined by the market for the land within its economy, the Government is better motivated to be effective with its spending. We suggest that the way this is done is through a Social Contract.

As the primary tax revenue for governments is determined by the market for the land within the economy, governments should collectively aim to efficiently allocate and develop land (as discussed in the ladder contract) as well as provide services that are beneficial to society.

We suggest a way to distribute this money fairly through what we call the Social Contract. The Social Contract is a contract between the Government and the people that determines how the tax revenue is spent. This is a democratic process, and the people will have a say in how the money is spent.

All Social Contracts operate at three levels:

1. An Individual Level
2. Within Local Communities (Local Government)
3. The Nation as a Whole (National Government)

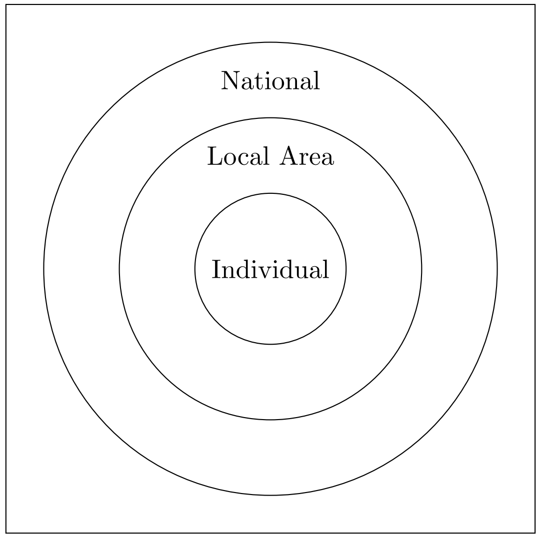


Figure 5: The Social Contract

The figure above is a visual representation of the Social Contract. The three circles represent the three levels of the Social Contract.

To better ensure fairness and reduce corruption, we believe that the only aspect of the Social Contract that should vary within a nation is the spending at the local level. This is because the needs of local communities can vary greatly and the people within these communities should have a say in how their money is spent. Additionally, the percentage paid to each level should be the same for all people. The is to ensure that some areas do not get more payment into the individual level than others.

Variation in the individual level could be beneficial, but we do not believe that it is fair or effective to require bilateral contracts between the Government and each individual. Some choice is good but the same choices should be available to all people and consistency is needed, particularly in the case of pensions.

2.2.2 Individual Level

We will mostly discuss pensions at the individual level, as this is the most significant aspect of the Social Contract at this level. We believe that a fair and effective pension system is important to motivate people to work and to ensure that people are not left without spending power in their old age.

The precise mechanism for pensions will ultimately be a political decision and will require tuning and further analysis. We will discuss a theoretical implementation, and parameterise it in a way that is flexible and can be adjusted to meet the needs of the people.

Exploring a simple theoretical pension system, we will work on the assumption of a constant population size, N, with no time variation in demographics (the expected number of people in each age group is constant). If we then define the working age as starting at a_w and ending at a_p, the retirement age, we can examine the pension system.

If a constant percentage, r_p, of the Social Contract revenue is paid into the pensions system, then the total revenue available for an individual pensioner is:

$$P_i = r_p \sum_{\tau=0}^{365(a_p - a_w)} (c_1(t-\tau))_i \tag{8}$$

If we then define the average life expectancy as a_l and pay this out uniformly over the life of the pensioner, the daily pension payment is:

$$p_i = \frac{P_i}{a_l - a_w} = \frac{r_p}{365(a_l - a_w)} \sum_{j=0}^{365(a_p - a_w)} (c_1(t-j))_i \tag{9}$$

If we define the average lifetime payments into the Social Contract of an age group as:

$$\bar{E} = \frac{\sum_{i=0}^{N} \sum_{j=0}^{365(a_p - a_w)} (c_1(t-j))_i}{T} \tag{10}$$

This implies that the average additional spending power of pensioners, D_p, in this group is:

$$D_p = \frac{r_p \bar{E}}{365(a_l - a_w)} \tag{11}$$

This model showcases a potential way to evaluate the effectiveness of a pension system and tune it to meet the needs of the people.

There are unanswered questions on the specifics of whether pensioners will still be required to pay for their house and if they will still receive the UBI, however, we believe that the UBI should be paid to all people. We note that pensioners will still be required to pay the savings fee, as this mechanism is required to be applied universally to all money to guarantee the stability of the money supply (as discussed earlier).

As the amount paid into the Social Contract, $\bar{E}$, is market driven the pensions will be parameterised by the percentage paid into the pension system, r_p, and further tuned by additional benefits (such as the free or reduced housing costs). Further work will be needed to determine the best way to tune this system.

There may be the need to introduce a cap on the amount any individual can contribute into the pension scheme. When capped, additional pension contributions could be refunded to the individual, or used to fund other services in the Social Contract.

2.2.3 Local Area Level

We theorise that the local area level of the Social Contract is the most important in determining land prices. We believe areas that aim to provide better services will have higher land prices, and this will be reflected in the tax revenue. Whether a price floor for land is introduced is a political decision, and will ultimately aim to achieve stability and maximise revenue for local areas. In other words, the price floor will be set to ensure that the local area is not undervalued and there is an incentive to provide valuable services efficiently and effectively that reflect the higher base land prices.

We hope that by providing local services this way local governments will be empowered to provide a variety of services that are tailored to the needs of the people in the area. For example, a local government may choose to differentiate on: the availability of public transport; community centres; schooling; or healthcare [4].

We note that care should be taken on how the local area is defined, as we do not aim to create a system that promotes inequality through the segregation of services at the local level. We would prefer to see local areas defined as entire cities or towns, as this will better ensure that the services provided are available to all people in the area. We may be wrong on this, and further work will be needed to determine the best way to define local areas. Ultimately, we trust in robust political systems to address these issues.

2.2.4 National Level

Similar to the local level, a price floor for land may be set to ensure that the national revenue is maximised. As this is a democratic system, the existence of a price floor for land is a political decision and will be set to ensure that the Government revenue is sufficiently stable and able to consistently provide the services that the people require.

Some examples of national spending include, but are not limited to: healthcare; education; defence; infrastructure; public research; and other public services. If this system is inefficient, the people will either be able to pay less for land or campaign for changes to the system. This is in line with our idea for a democratic taxation system, where the people can choose to pay more or less tax based on the services they receive.

2.2.5 Voluntary Taxation (Contributions)

Due to the nature of the ladder contract requiring payment at a fixed rate for a minimum period, we recognise that this is a risk for people who may experience volatility in their income. To address this, we propose an additional measure of voluntary taxation where people may opt to pay more tax in times of high income, without changing the terms of their contract. This would likely be to support their pension contributions, but could also be motivated by other perceived benefits of additional contributions into the social contract. To achieve this, we propose a system that allows their payment into the social contract to be defined as a function of their income:

$$e_1 = \max(c_1, f(I)) \tag{12}$$

Where $f(I)$ is a function of an individual's income, post-payment of their ladder (land) contracts.

This way the additional voluntary tax will not affect the terms and functioning of the ladder contract, but will allow people to pay more tax in times of high income.

The form of $f(I)$ will be a political decision, as this can have implications on the stability of Social Contract revenue. A simple form, that could be effective, would be:

$$f(I) = r_V I \tag{13}$$

Where r_V is the voluntary tax rate.

[4] We note that healthcare is a national service in the UK, and we believe that this is the best way to provide healthcare. How this is split between local and national will, once again, be a political decision and we touch upon this again in the next section

Additionally, these payments could be purely voluntary and not enforced through a recurring agreement. This way $f(I)$ would be the most general form, where people can choose to pay more tax at any time, but this could have implications on the stability of the Social Contract revenue.

2.3 Borrowing and Debt

2.3.1 Introduction

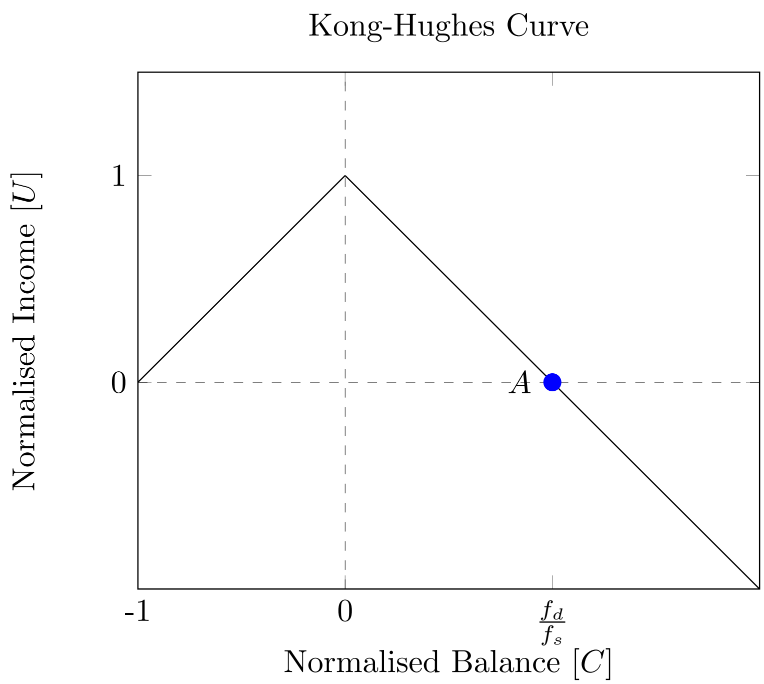
We have not yet discussed borrowing and debt within our system. We believe that private borrowing and lending are incentivised in our system through the savings fee. However, we recognise that without an institutional mechanism, there may be a lack of access to credit for some individuals.

We hope that the lack of access to credit is truly reflective of a lack of demand for what they are offering, but we recognise that this may not always be the case.

2.3.2 Institutional Lending

The original outline for the core system included a credit system for all individuals. We had initially proposed giving access to credit to all individuals, subject to a debt fee, f_d.

Visually this system can be represented by the following figure:



Where the point A is determined by

$$A = \frac{f_d}{f_s} C = \frac{U}{f_s} \tag{14}$$

This is the point that individuals would reach if they were to save all their UBI.

The concern with this system is that now money creation is not as stable, and the money supply would fluctuate with the number of loans taken out. Additionally, if individuals were permanently indebted they would permanently lose out on their UBI, which would further affect money creation in the system.

Other systems could be implemented, but ultimately we believe that private lending is a better solution. This is discussed in the next section.

2.3.3 Private Lending

For individuals with high incomes who are unable to spend all of their income, we would hope that they would lend to create more opportunities in the economy.

Financial returns could still be a motivator, however as the money supply is fixed and all subject to the savings fee, this opportunity is not available to all. Investors who are better at seeing opportunities that might be enjoyed by others could still make a profit, but by not investing in what you enjoy, you are trading off self-expression for (perceived) financial returns; these financial returns come from investing in what others will enjoy, and therefore, what they will spend their income on.

In this view, spending and investing your income are both forms of self-expression. It is up to the individual to decide what they value, which we see as a positive aspect of our system.

Ultimately, through the democratic spending lens, we see not spending your income (and saving) as equivalent to not voting and being unable to express yourself. All individuals in the economy will have this same experience, and the ability to know and understand yourself is part of the human experience, so we see mirroring this in the economy as a positive.

This aligns with our views on saving in our system. In our system saving is due to uncertainty, either in one's self or in the future. By disincentivising saving, we are discouraging uncertainty. In the current system people also save for a specific purpose, such as for a car; in our system they will commit to this by, in essence, financing the car. This is a positive aspect of our system as people are incentivised to better communicate what they want to the market, so the market better provides it. We already see consumer satisfaction in 'buy now pay later' schemes [5], with no interest payments, and we believe this will be a prevalent feature of our system.

The predicted shift in spending and investing habbits in our system could be seen as promoting people to take more risks, but we see it as promoting people to take more action. We believe this results in our economy being a better reflection of the people within it, and by encouraging people to act, we are encouraging the economy to grow and develop.

Whether investing is done through a investment institutions or through peer-to-peer lending will depend on individuals behaviour and the opportunities available to them. Ultimately, as people will be motivated to effectively invest in what they enjoy or get value from,people will hopefully be able to find the right investment opportunities for them depending on the time and effort they are willing to put in.

2.3.4 Government Borrowing

While we hope that the Government should be able to fund itself through the Social Contract income, there may still be extreme circumstances where the Government needs to borrow.

Our system will not have traditional Government borrowing mechanisms, such as Government bonds, as these are supported by risk-free interest rates and require a growing money supply.

Instead, we will show how Government borrowing can be achieved just through creating new money. This will effectively be the Government borrowing against its people, as this money creation will devalue the UBI through a temporary increase in the money supply.

The steady state money supply, with Government money creation is given by:

$$T = \frac{Nu + G}{f_s} \tag{15}$$

Where G is the (daily) money creation by the Government used to support its spending. This assumes that the Government spending is time-invariant (see appendix **??**), and therefore not transitory. If, instead, the Government is only temporarily planning to spend in this way, this money will eventually be removed from the system, and the money supply will return to the UBI level.

Once Government spending through this mechanism stops, the rate at which the money supply returns to the UBI level is dictated by the savings fee.

2.4 International Trade

2.4.1 Introduction

We will now discuss international trade within our system. So far we have mostly discussed the domestic economy, and treated the economy as a closed system. However, naturally, international trade is an important aspect of the economy.

We propose a definition for an equilibrium exchange rate, which agrees with conditions seen at real equilibrium in current foreign exchange markets. Recognising that current foreign exchange markets will not suit our system, we propose a new mechanism for foreign exchange.

Our proposal neatly ties fair trade and foreign exchange together, in a way that is not currently clear in the current system.

2.4.2 Importance of Fair Trade

The money supply of a country was previously defined as:

$$T = \frac{Nu}{f_s} \tag{16}$$

Where T is the money supply, N is the number of people in the economy and u is the daily Universal Basic Income (UBI) payment.

This result was true for a closed economy. To generalise this for an open economy, we need to consider the net (daily) capital inflows and outflows, K, where K is positive for a country that is a net exporter.

The money supply in this case is then:

$$\mathbb{E}[T] = \frac{Nu + \mathbb{E}[K]}{f_s} \tag{17}$$

Where $\mathbb{E}[.]$ is the expectation operator. This recognises that daily capital inflows and outflows will likely be a stochastic process.

For a country to have control over its money supply, it must achieve a target level of capital inflows and outflows. Applying the democratic spending lens, we can see that a country who is a net exporter effectively devalues the UBI, and therefore its people. We will therefore target balanced trade, where $\mathbb{E}[K] = 0$, as no country should be able to devalue another's UBI.

2.4.3 Equilibrium Exchange Rate

We will consider the case of trade between two countries A and B, with the exchange rate e_{AB} and capital flows K_{AB} and K_{BA}, where K_{AB} is positive for imports from A to B.

We then define the equilibrium exchange rate according to the following condition:

$$\mathbb{E}[K_{BA}] = \mathbb{E}[K_{AB}]e_{AB} \tag{18}$$

This condition implies that the spending power each country has on the other is equal. This condition is also met at real equilibrium in current foreign exchange markets, although we will critique current foreign exchange markets later.

2.4.4 Achieving Equilibrium

While we recognise that the conditions for equilibrium in Equation 18 are met in current foreign exchange markets, we do not believe that market makers can easily function in the presence of a savings fee as they are unable to hold money.

The breakdown of traditional market makers is also true elsewhere in our system, see our appendix on gold markets for more information B. This is not to say there is no way for them to operate, but as the savings fee would be priced into the exchange rate, we believe that the market would be less efficient.

We propose that instead of holding money for exchange, money could be created at the point of exchange. This would avoid initial complications of the savings fee, but will require an alternative mechanism for foreign exchange.

Ultimately we believe the best way to achieve this is through modelling the (stochastic) process of foreign capital flows and setting the exchange rate accordingly. This would require a centralised system that both countires (parties) agree too, and would be an additional administrative function of the Central Bank.

A very simple process for this could be a moving average (MA) process, where the exchange rate is set as the average of the last n days of capital flows. This would be a simple way to ensure that the exchange rate is fair, and would be easy to implement. The limitations of certain models will require further research, but we believe that progress in this area is possible and ensures the mechanism is best aligned with achieving fair trade.

2.4.5 Conditions of Exchange

As the ultimate goal of our foreign exchange mechanism is to achieve fair trade we do not believe that it should be possible to exchange currency directly.

By limiting exchange to the purchase of goods and services, we ensure that the exchange rate is not affected by other factors. For example, if both countries implemented our core system, there may be a temptation to exchange currency directly to countries with lower savings fees.

This could be achieved by only allowing people to hold bank accounts in countries where they are citizens or residents of. While this will not entirely remove the ability to exchange currency directly, this opportunity should only be available to a small number of people with multiple citizenships. Additional regulation and oversight could further be implemented to prevent this; it is not in the interest of countries to allow this to happen as this would devalue their UBI, although it may provide more favourable conditions for imports.

2.4.6 Concern with Current Foreign Exchange Markets

Current foreign exchange markets are not guaranteed to align with achieving fair trade. This is because the market participants have to be aligned with this goal for it to be achieved.

For example, in current "free" foreign exchange markets people can exploit the strong currencies of net exporters to get more favourable exchange rates themselves. While this may result in the same equilibrium condition as in Equation 18, it is not a result of fair trade.

3 Sustainability and The Fire Economy

3.1 Introduction

We consider how the economic decision-making of agents is influenced by monetary policy. We do this by considering a simple model where agents maximise their average returns under different monetary policies given a price envelope and physical supply constraints. To simplify our analysis we assume that everything produced is consumed.

Our analysis suggests that the presence of a systemic risk-free rate (such as interest payments from Government bonds) that is higher than inflation causes price instability and encourages unsustainable behaviour. This section is to further justify our call to action for monetary reform, as we believe the current system is ineffective at addressing the issues of sustainability and price stability.

3.2 Model

Our model consists of a single agent who owns a fixed amount of land, which can be set on fire to generate income. The agent can choose to burn all the land immediately or burn a fraction of the land. The burned land regrows at a fixed rate, and the price is fixed at a given moment in time and is known to the agent, $p(t)$.

The model parameters are as follows:

- L: The amount of land owned by the agent
- R: The land regrowth period
- p(t): The price per unit of land set on fire
- q(t): The quantity of land set on fire
- h(t): The savings mechanism (monetary policy)

The agent's objective is to maximise their average returns, which we define as the total income generated by burning the land in a given period. We will consider two different monetary policies: one with a positive risk-free rate (such as systems built on interest) and a savings fee.

3.3 General Case

We will first consider a general case for a general price envelope, p(t), and a general savings mechanism, h(t). We will then maximise the average returns in a fixed period, T, and investigate how the optimal strategy, q(t), changes.

Mathematically, the average returns in a period, T, $\rho(T)$, are given by:

$$\begin{aligned}\rho(T) &= \frac{1}{T}\int_0^T (pq * h)(t)dt \\ &= \frac{1}{T}\int_0^T \int_0^t p(t-\tau)q(t-\tau)h(\tau)d\tau dt\end{aligned} \tag{19}$$

The optimal strategy, $q(t)$, is given by:

$$q(t) = \arg\max_{q(t)} \rho(t) \tag{20}$$

subject to the constraint:

$$\int_t^{t+R} q(\tau)d\tau \leq L, \quad \forall t \in [0, T-R] \tag{21}$$

We can simplify the problem by working in the Laplace-domain, where the average returns, $\rho(s)$, are given by:

$$\rho(s) = \frac{1}{sT}P(s)Q(s)H(s) \tag{22}$$

As we only consider the case where $h(t)$ acts as an interest rate (directly applied to savings)

$$h(t) = e^{\alpha t} \tag{23}$$

this simplifies Equation 22 to:

$$\rho(s) = \frac{1}{sT(s-a)}P(s)Q(s) \tag{24}$$

We will express the price envelope, $p(t)$, as some base price fluctuations and core inflation:

$$p(t) = p_0(t)e^{\gamma t} \tag{25}$$

Maximising the real returns by adjusting for inflation yields the following equation:

$$\rho(s) = \frac{1}{sT(s-a+\gamma)}P(s)Q(s) \tag{26}$$

3.4 Efficient Markets

We will now consider a case where the price envelope, $p_0(t)$, is a random walk. This is a common assumption for efficient markets as it implies that everything that can be known about the price is already known.

If $p_0(t)$ is a random walk with a mean of μ and some variance, σ^2, then the price envelope, $p(t)$, is given by:

$$p(t) = p_0(t)e^{\gamma t} = \mathcal{N}(\mu, \sigma)e^{\gamma t} \tag{27}$$

If the inflation rate of the price of burning land, γ, is reflective of inflation in the wider economy then, from Equation 26, we can consider maximising the real returns by maximising:

$$\begin{aligned}\mathbb{E}[|\rho(s)|] &= \mathbb{E}\left[|\frac{1}{sT(s-a+\gamma)}P(s)Q(s)|\right] \\ &= |\frac{\mu}{sT(s-a+\gamma)}||Q(s)|\end{aligned} \tag{28}$$

To maximise the expected returns, we now must consider three cases:

- $\gamma > a$: Where the returns are stable (poles are in the left half-plane)
- $\gamma < a$: Where the returns are unstable (poles are in the right half-plane)
- $\gamma = a$: Where the returns are marginally stable

We will show that this distinction is important because all agents following the optimal strategy in the stable case, $\gamma >= a$, results in price stability and increased value of sustainability. In the unstable case, $\gamma < a$, the opposite is true.

Finally, in the marginally stable case, $\gamma = a$, there is no push towards either price stability or instability.

Inflation > Interest Rate

Without loss of generality, we will consider the case where $T = R$ [5]. In this case, we know that $|Q(s)| = L$, as an agent will always be best off burning all their land within the period, T.

Optimising for the case where $T < R$ is equivalent to the case where $T = R$, as the constraint is the same.

As this problem can now be viewed as periodic with period T, we can maximise the average real returns by maximising the steady-state gain of Equation 3.

The frequency response of the system is:

$$\rho(\omega) = \frac{\mu}{\sqrt{1+(\omega(\gamma-a))^2}}Q(\omega) \tag{29}$$

[5] This is because if agents are considering a shorter time frame than the regrowth period, they act as though the regrowth period is the same as the period they consider.

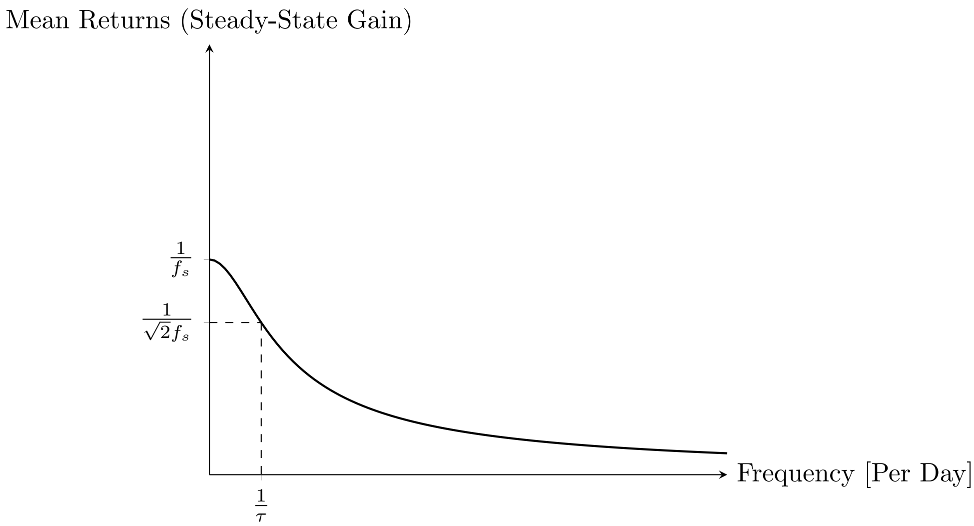


Figure 6: Frequency Response of Mean Returns.

As the total quantity produced is constrained (bounded) and is the same for all frequencies, this implies that the optimal strategy is to produce at a frequency of $\omega = 0$, which implies burning land at a constant rate:

$$q(t) = \frac{L}{\min(T, R)} \tag{30}$$

Inflation = Interest Rate

In this case, the optimal strategy is not as strict for price-takers, they have the freedom to burn at any rate and should choose the rate that maximises their returns.

The optimal strategy is dependent on the behavior of other agents in the market, however, if agents stick to the same strategy we would expect the market to better respect the mix of agents strategies, as there is no incentive to burn all the land immediately.

Inflation < Interest Rate

For the 'unstable' case, we cannot perform the same steady-state analysis as the poles are in the right half-plane.

However, the optimal strategy for a price-taker in this case is simple: burn all the land immediately. This is because the agent is best off burning all the land and investing the money in the risk-free asset.

If we further consider all agents following this strategy, it is unlikely that prices will not reflect this behaviour, at some level. This then becomes a game of trying to produce as early as possible when others are not.

If we consider a general demand curve for burning of land, $P(Q)$, that does not vary with time, then the optimal aggregate quantity of land to burn is:

$$Q^* = \arg\max_Q P(Q)Q \tag{31}$$

The effect of a positive real interest rate is discounting this price. Constraining the total quantity produced in the period, T, to be Q_T, we would expect more land to be burned at the beginning of the period.

Even if equilibrium is reached, the price will be lower at the start of the period due to higher quantities of land burned, reflecting the fact that agents are discounting future returns. Ultimately, this can cause supply-side inflation as a response to lower demand-side inflation.

This assumes that the market is perfectly efficient which requires perfect information. This is unlikely to be the case in reality as agents will never know how much land other agents are burning, and is made worse when agents have different amounts of land.

For the agents with less land, they might, individually, act more as price takers so they will still want to burn all their land immediately. Agents with more land, who act more as price makers, will then have to adjust for this and burn their land slower. Alternatively, they could (intentionally or not) discover that manipulating the price, by burning more at the start, disincentivises price-takers from burning all their land immediately, increasing their own profits. Ultimately, they would all be better off if they agreed to burn their land at a given rate, but this is unlikely to happen without some form of coordination.

We see coordination in practice with the OPEC oil cartel. The cartel is a group of oil-producing countries that agree commit to oil production targets to collectively keep prices high [6] [6].

Compliance to the agreed targets is not perfect [7], which we believe arises, partly, from the same incentives for price-takers to burn all their land immediately.

The effect of this is instability in supply and prices, which is not in anyone's best interest.

We predict that if real risk-free returns did not exist, such as in our system, then the cartel would not be necessary, as the optimal strategy is the same as the cooperative strategy. This is not only better for all economic agents, but also positively affects: supply and price stability in addition to sustainability.

3.5 Constant Production Incentive

We will now consider the same model as in but with our proposed monetary policy.

As there is no core-inflation (see section 1.6), the 'real-interest rate' felt by each agent is just the savings fee, f_s.

This implies that the result for the optimal strategy, $q(t)$, will be the same as the case when the risk-free rate is lower than the core-inflation rate. This means that economic agents will always be incentivised to burn the land (produce scarce goods) at a constant rate:

$$q(t) = \frac{L}{\min(T, R)} \tag{32}$$

As we have direct control on the savings fee (real interest-rate felt by individuals) we could tune the incentive for economic agents to produce sustainably by adjusting the savings fee.

We do not have control over the time period, T, that economic agents consider, which means that achieving sustainability is not guaranteed. For example, fossil fuels will never regenerate, so policy should be targetted to try and promote economic agents to consider longer time periods.

[6] This paper reviewing OPEC production policy does not recognise the effect of risk-free (or alternative financial) returns. We believe this is an oversight, and suggest they are implicitly assuming that core inflation is equal to the risk-free rate.

The ability to effectively target policy will be crucial in achieving climate goals. As discussed in Roeber (2023), "climate mitigation measures did not affect OPEC production policy during the period analysed" [6].

3.6 Benefits of Constant Production

Not only does a constant rate provide a step toward sustainable production it also provides a step toward price stability and certainty in markets.

If agents expect other agents to produce at a constant rate and not suddenly flood the market, then they can be more certain about the price they will receive for their goods. This is enhanced by a stable money supply and a lack of core inflation.

Therefore, we expect that people who enter markets do not do so speculatively, but do so intending to commit to a certain level of sustained production. Combined with increased social welfare and security (discussed in the next section), we believe this will lead to an economy where people better specialise in what they are good at and enjoy, as well as people being more willing to take responsible risks and innovate. To us, this is what a free and expressive economy is, and takes us back to an era of enlightened self-interest and away from entitled selfishness.

3.7 Aside on Efficient Markets

Earilier we assumed that any changes in the demand curve, reflected in changes in price, are due to changes in the core inflation rate. This was a simplification, as there may be other predictable factors that affect the demand curve, and therefore the price. We avoided this complication by assuming that markets are efficient and that all other information is already known and priced in.

In reality, this is unlikely to be the case, but we have assumed this to simplify our analysis down to the effects of core-inflation and risk-free rates.

Wider demand-side inflation, specific to the good being produced, could violate our assumption of a random walk for the price envelope, $p_0(t)$. This could result in behaviour where agents wait to produce as they expect the price to increase, irrespective of increased supply from other agents. Due to dispreference for unstable (volatile) income in our system, as this does not facilitate purchasing land, we believe there will still be a strong incentive for constant income, and therefore, still favour stable (sustainable) production.

Therefore, in our full system, we believe the incentives for stable and sustainable production are resilient to both changes in the supply and demand of the good being produced.

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4 Usage Rights

A Total Money Supply

Discrete Time

For an economy with a savings fee, f_s, applied to all money in the economy (at fixed discrete intervals t), and money is created in the economy through a time-invariant (stationary) process, $o_c(t)$, we can solve for the total money supply, $T(t)$, in the economy.

We will re-parameterise the savings fee, f_s, in terms of a time constant τ. This allows for easier comparisons to continuous time models. The relationship between f_s and τ is given by:

$$f_s = 1 - e^{-\frac{t}{\tau t}} \tag{33}$$

If $o_c(t)$ is a constant, o_c, then the equation above simplifies to:

$$T(kt) = o_c * (1 - f_s)^{kt} = \sum_{\tau=0}^{kt-1} o_c(1 - f_s)^{\tau} \tag{34}$$

This is simply a geometric series, resulting in the following equation:

$$T(kt) = \left(\frac{o_c}{f_s}\right) \cdot \left(1 - (1 - f_s)^{kt}\right) = \frac{o_c}{f_s} \cdot \left(1 - e^{-\frac{kt}{\tau}}\right) \tag{35}$$

This implies that the steady state money supply, T, as $k \to \infty$, is given by:

$$T = \frac{o_c}{f_s} \tag{36}$$

We recognise that this is a discrete time first order system.

Continuous Time

For ease of analysis, we have also considered continuous time in some of our models. We will now derive the continuous time equation for the money supply, and show equivalence with the discrete time model.

The derivation for this can be done by considering the continuous time equivalent of Equation 34.

$$T(t) = o_c * e^{-\frac{t}{\tau}} \tag{37}$$

Applying the Laplace transform to this equation, we get:

$$\mathcal{L}\left\{T(t)\right\} = \frac{o_c}{s(s + \frac{1}{\tau})} \tag{38}$$

This can be inverted to give the equation for $T(t)$ in continuous time.

$$T(t) = \tau \cdot o_c \cdot \left(1 - e^{-\frac{t}{\tau}}\right) \tag{39}$$

From Equation 33, we can express τ in terms of the savings fee:

$$\tau = -\frac{1}{\ln(1-f_s)}$$
$$\implies T(t) = \frac{-o_c}{\ln(1-f_s)} \cdot \left(1 - e^{-\frac{t}{\tau}}\right) \tag{40}$$

Now, assuming f_s is small, we can use the approximation $ln(1 - f_s) \approx -f_s$ to simplify the equation:

$$T(t) = \frac{o_c}{f_s} \cdot \left(1 - e^{-\frac{t}{\tau}}\right) \tag{41}$$

Showing that the continuous time model is equivalent to the discrete time model for sufficiently small f_s. This implies choosing a sufficiently large time constant τ to keep the savings fee small.

We note that if you wanted a larger savings fee, you could reduce the period of the discrete intervals t. For comparison between continuous and discrete time we have required that the discrete-time time constant τ is dimensionless. However, if we want the same effect in a given discrete time period, we can scale the dimensionless time constant by the discrete unit of time we apply the savings fee.

$$\frac{t_1}{\tau_1 t_1} = \frac{kt_2}{\tau_2 t_2}$$
$$\implies \tau_2 = k\tau_1 \tag{42}$$

Which suggests that we can increase the time constant, τ_2, by considering smaller discrete units of time t_2 and k larger. This also demonstrates why we get agreement between the continuous and discrete time models, as in the limit as $k \to \infty$ this implies moving from discrete time to continuous time and this results in the savings fee going to zero, $f_s \to 0$.

In the paper we do not need to move between discrete and continuous time models, although we do currently use both, so for simplicity we consider τt and assign units to our time constant.

Continuous to Discrete Time Mappings

We note that all our systems analysis in continuous time is for stable continuous time systems. These have stable discrete-time mappings, through backward difference and Tustin methods. [8]

Additionally, we could reconsider our analysis in discrete time, using the Z-transform, to get a more accurate representation of the discrete time system. As our analysis in continuous time is more conceptual, and for sufficiently small savings fee, we do not expect our conclusions to change. If this raises a large concern for others, we would consider redoing our analysis in a future version of this paper.

B Gold Markets

We consider a market maker for gold who buys at a price p_b and sells at a price p_s.

However, for the market maker to commit to buying back the gold, they must hold the money. Therefore, in the presence of a savings fee, f_s, if the average holding time of buyers of gold at the price p_s is δt, the market maker will only have $p_s(1 - f_s)^{\delta t}$ to buy back the gold.

Therefore the profit of the market maker for a given spread, $psi = p_s - p_b$, is:

$$\pi = p_s((1 - f_s)^{\delta t} - 1) + \psi \tag{43}$$

If the people holding gold only do so as an investment, with the intention of selling it back to the market maker at a later date to avoid the savings fee, the market maker will not be able to make a profit.

Therefore, the only way for the market maker to operate is if they themselves can avoid the savings fee, by finding better returns elsewhere. In essence, the market maker will have to act as an investor. This highlights how investment opportunities do not need to promise financial returns, but can instead offer reduced effective savings fees.

An alternative way market makers can function is if people actually value holding the gold, and are therefore not buying it as in investment. This highlights the importance of self-expression and subjective value which builds an economy that is primarily a reflection of the people within it. Assuming gold does have subjective value, this creates a market where gold also functions as a store of subjective value [7].

People are best off when the 'assets' they buy balance perceived value to themselves and others. As we can never expect others to fully value things the same as ourselves (or even truly know what we value), there is a trade-off between buying things we think we presently value and buying things that we know others currently value (as signalled by the market price) - such that we lose less if we are wrong about ourselves and decide to sell.

As people become more certain in what they value, and therefore care less about reselling, people may become more willing to buy things that are valuable to themselves instead of others. This is a positive aspect of our system, as it encourages people to know themselves and what they value.

This aligns with another interpretation that markets in our system facilitate self-expression and the allocation of resources to those who can value them the most. We say 'can' here as this is conditional on how much they earn, and therefore, how much their economic contributions have been valued by others.

[7] This ties into a philosophical, that is in currently in progress, on what I call 'conditional objectivity', which posits that we can make objective statements about subjective experiences, but that these may not be true for all people, and therefore, for all time. This explains what I see as an easily held false belief that there is a universal truth to all our common experiences.