# The Relative Theory of Money in Detail

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June 12, 2016

## Contents

## 1 Introduction

The aim of this text[1] is to present Stéphane Laborde's relative theory of money (RTM or TRM in French) in an accessible way, without compromising on completeness and rigour. The mathematical part is written as to be accessible to secondary school students.

The text starts with a general introduction to the notion of value and presents some basic economic arguments in order to prepare the reader to the concepts developed in the RTM. The theory is then presented in section 3, which makes up the core of the text.

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**The RTM in brief**

Nowadays, money is created by private banks, what gives them power on the economy. The RTM shows on the contrary that if we want to preserve our economic liberties, we must let everyone share the benefits of money creation equally. Since creating money changes its value, the RTM ensures that every past, present and future individual can benefit from the same monetary *value* during his or her life.

The strength of the theory lies in the fact that it accounts for this temporal dimension so that no generation gets an advantage regarding the money it disposes of.

**Version notes**

In this first version, the main part of the theory is presented, neglecting a few minor points. These points will eventually be included here. It is also planned to treat some points more in depth as empty sections show.

Every comment is welcome!

## 2 Price, value and money

In today's society, we are continuously led to trade goods and services with our peers. These trades are based on the importance and interest that each one takes in the traded goods, in other words, on their *value*. The notion of value is fundamentally subjective: two different individuals don't comprehend the world the same way and hence don't have the same preferences.

Almost all trade is currently done through money: goods are traded for some quantity of money, called *price*. A good's price doesn't necessarily reflect the value given by those involved in the trade: I could very well sell my car for 8000€ to someone who would give as much as 10000€, while I really think myself that it is only 5000€ worth.

We already see thanks to this example that money comes in handy for several reasons:

1. since it is accepted and seeked by all, it facilitates trade;

2. it allows us to give a concrete measure — just as the meter allows to measure distances — to the subjective value of a good, by estimating the price at which one would buy or sell it.

Although the notion of value is subjective and a good's price can greatly vary from trade to trade, we'll see in the following sections how to determine a "standard" price, which takes into account the preferences of all economic players: the *market price*.

### 2.1 Demand and supply

By an *economic zone* (or sometimes *community*) we'll mean a determined set of individuals who trade goods and services. To fix ideas, let's take a good, meat for example, and let's try to determine which factors influence its price (we don't distinguish between types of meat).

Some people love meat and would be willing to spend as much as 30€ for a kilogram. Others can do without and wouldn't give more than 10€ for a kilogram: meat value varies greatly between individuals.

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We can aggregate these preferences to get what's called a *demand curve*. This curve determines, for every hypothetical price level, the quantity of meat that will be sold in our economic zone. It's constructed by answering the following question: "Assume that meat sells everywhere for $X$ €/kg, what quantity of meat will the whole population buy?" To each price level $X$ corresponds a some quantity of meat, what gives us a point on the curve. Unsurprisingly, meat at 10€/kg sells better than meat at 50€/kg. We hence get a decreasing curve as below:
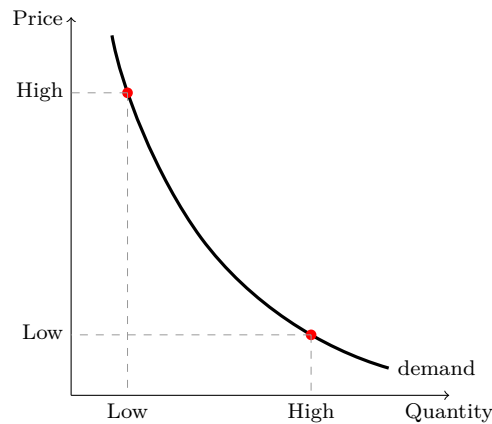


The lower the price, the larger the demanded quantity in the whole economic zone.

Besides, we also have meat producers, who provide meat *supply.* They face more or less high costs according to their personal circumstances. Producers with low costs will accept to sell their meat at a lower price. If they can't sell at a sufficient price, some producers will have to stop their business, since they can't cover their costs. Conversely, if the expected selling price rises, it will eventually lead new people to start producing meat. This relation is illustrated by an increasing curve, as shown below.
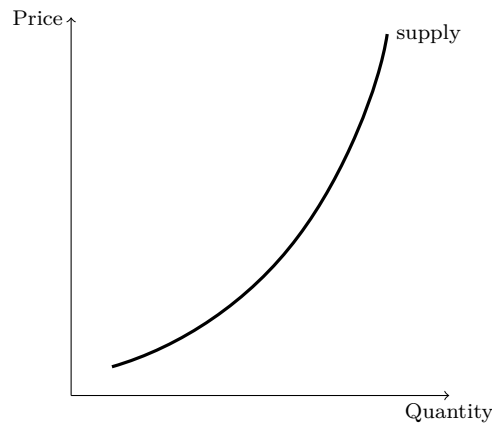


The higher the expected selling price, the more will *eventually* be produced.

We already heavily stress this point: the above supply curve doesn't mean "if one can suddenly sell meat at a higher price, meat supply will instantly increase". This transition takes on the contrary quite a long time to be achieved: today's producers gradually increase their production, and new businesses come progressively into play. Time is thus essential in this process, but it is not shown at all on the graphic, which actually keeps many mechanisms hidden. In particular, an instant supply curve, taken at a given moment would look more like this:
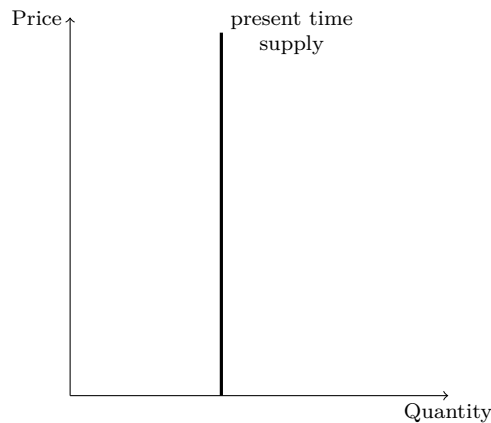
This line mirrors the fact that producers can't adapt their production overnight to satisfy a different price level.

We made it clear that supply is very rigid: it takes time to produce goods and leftovers don't vanish by themselves. Demand can evolve a lot quicker though: the masses can rush to shops overnight, and drive up demand.

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### 🛈 The growth of the supply curve

It could look counterintuitive to have an increasing supply curve: don't we get discounts on large purchases? This dynamic is entirely different from what we saw before. It happens on the spot for several reasons:

- uncertainty decreases for the seller: it's best to sell at lower price and to be sure that everything goes away;

- customer loyalty: it allows to create a trust relationship with the customer.

Indeed, as we've just seen, demand evolves a lot quicker than supply and it is common that a producer ends up with a surplus, that he prefers to sell sooner at lower price than to throw away.

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We talk about *meat market* to refer to the interaction between people seeking to buy meat, who provide demand, and people who produce meat, who provide supply. Combining the two curves, we observe that they cross at a point, called *equilibrium*.
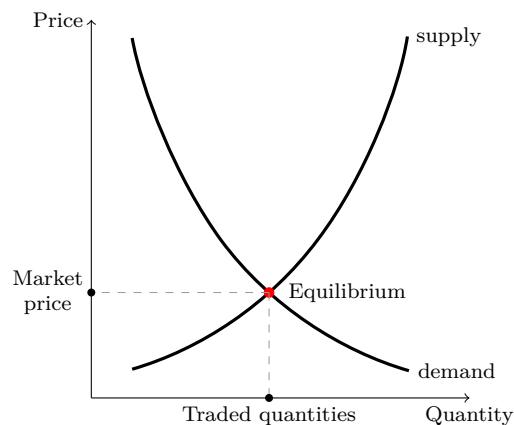
This point determines the price at which meat would be sold in an idealized free market, as well as the quantities that would be traded for this price. This price is called the *market price.* It corresponds to the price above which no one would want to buy meat, because they'd always be able to find some producer willing to sell at the market price, and below which no producer would want to sell meat, because they could always find someone willing to pay the market price.

In other words, by taking into account all people's preferences via demand, and global availability via supply, the market price reflects the global value given by the whole population to this good, that is to say, a kind of average value somehow.

> 🛈 **Global and local value**
>
> The notion of value is very personal. Some are willing to pay hundreds for a football ticket, others wouldn't give a penny. And yet, these tickets are sold at a fixed price, that can very well be inferior or superior to the buyer's own estimate.
>
> We'll often use the word *local* to speak about something related to a single or a small group of individuals, considered separately from the whole. One could thus rephrase the above discussion by saying that the local value of a football ticket is very heterogenous.
>
> Conversely, the term *global* will be used to speak about the community as a whole. In particular market price is a global notion in itself, since it is determined by the aggregate of each individual's preferences through demand, and it takes into account the whole economic zone's supply.
>
> When we say, without any further detail, that a good has "more value" than before, we implicitly take a global viewpoint. Hence it doesn't mean that it will be more valuable for everyone, taken separately, but that the society as a whole puts more value in it.

## 2.2 Evolution of demand and supply

Demand and supply curves evolve through time. For instance, if more and more people turn vegetarian, then meat will find less takers for a same price. We say that *demand decreases.* The effect of this is a shift of the curve to the left: for each price level, the demanded quantity gets lower.
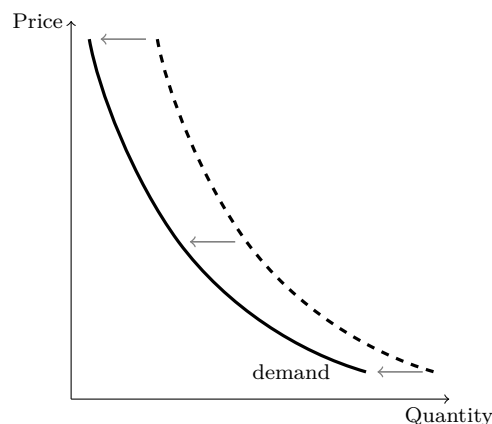
Conversely, if there are more buyers than before for a same price, demand increases and the curve shifts to the right.
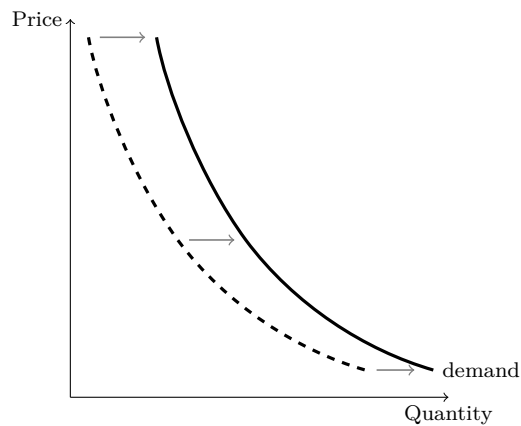


We need to carefully distinguish two different principles here:

1. when meat price drops, more people are willing to buy meat, this is expressed by the *decreasing look* of the demand curve.

2. when an external factor causes more people to buy meat *for a same given price*, we get a lateral shift of the entire curve. This is what is meant here by increase of demand.

Supply can also change: if the price of feeding farming animals rises, meat producers will face higher costs and will put less meat on the market for a same price. This is expressed by a shift to the left of the supply curve.
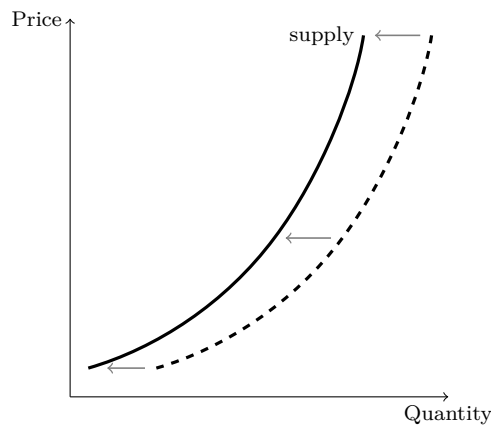


Contrariwise, the effect of a supply increase is a shift of the curve to the right.
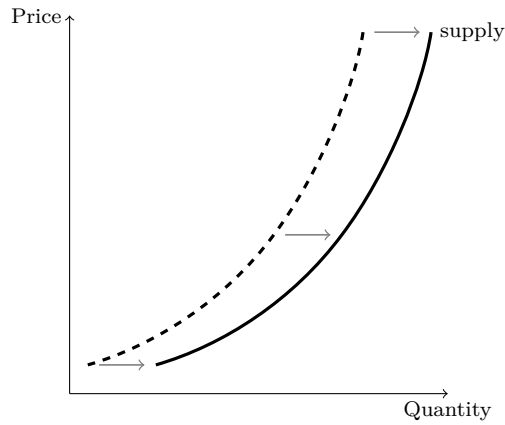
Let's look into a concrete example that illustrates how demand and supply interact. We start from an equilibrium on the meat market as shown below.
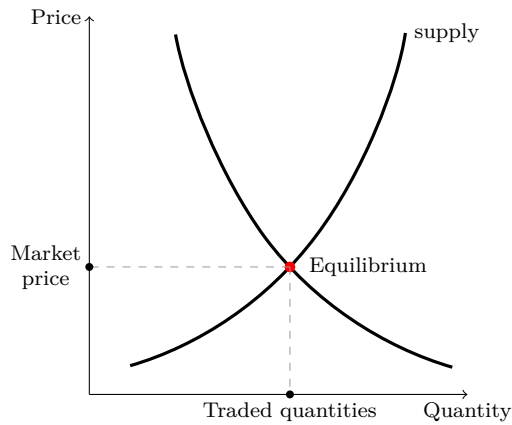


One day, a new scientific study challenging our eating habits claims among others that meat consumption is highly carcinogenic. These alarmist conclusions attract media coverage. In reaction, many people worried by their health reduce their meat intake, what leads to a decrease in demand, as shown below:
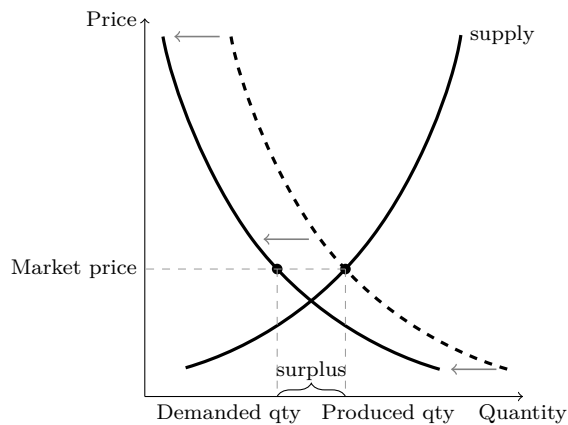


Of course, producers don't have enough time to adapt to this unexpected consumption drop and end up with many unsold items, as can be seen on the graphic. In reaction,

they are going to progressively align their prices on the demand, in order to sell their stock and limit their loss.
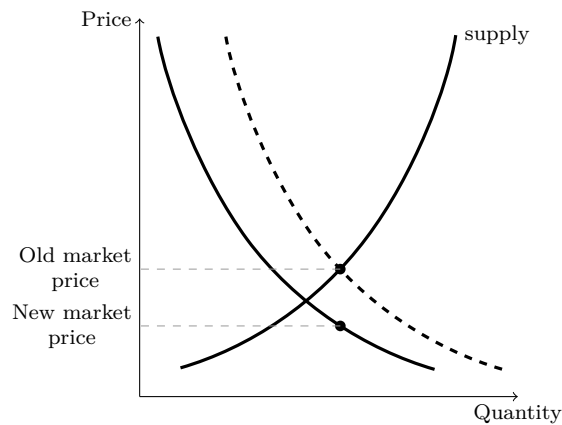


Now, this decrease in meat consumption lasts in the long run and some producers are forced to stop their business, since they can't find enough customers to cover their costs. This will progressively reduce supply (we move on the curve). Since there is less meat put on sale, buyers will be willing to pay a bit more and producers will be able to raise their prices, what will contain their loss. The process goes on until a new equilibrium is reached.
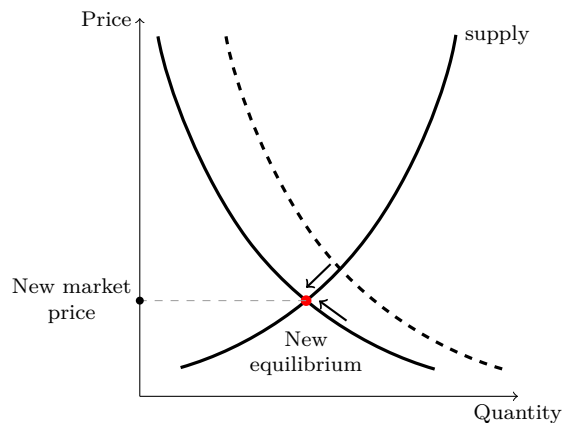


Finally, we see that the actual price level depends essentially on two things:

1. tha available quantity on the market (given by supply),

2. the exisiting demand for this good.

These conclusions are quite intuitive: an old stamp with only 5 remaining pieces in the world will have much more value (we mean global value here) that a stamp of which 100000 copies were printed last year. But availability is not all: if nobody collected stamps, who would spend a fortune for a piece of paper? This old stamp wouldn't be worth anything anymore. The same holds in general, even if it can get quite subtle for some types of goods.

It is also time to make another crucial observation: if the production of a good is entirely controlled by a particular person (we say that she has a *monopoly*), this person

has a huge advantage over the others: she can determine alone the price level, hence the global value of the good, just by adjusting her production. In ideal conditions, competition should prevent this kind of situation, but in reality, it is another story...

> 🛈 **What is speculation?**
> We've just seen that the price of a good is determined by demand and supply and can evolve through time. Speculation consists in buying a given good, not out of need, but in the hope to sell it later at a higher price, so as to make a profit. Ironically, speculation justifies itself *a posteriori*: it artificially inflates demand, what causes prices to rise! Consequently, the market attracts other speculators who want to take advantage of this price increase, and it gets only worse, creating what's called a speculative bubble. Until the day these accumulated quantities are sold in bulk, what suddenly drives supply up and pushes prices down: the bubble bursts.

## 2.3   Money and price change

Money has a central role in the economy, since it is involved in almost all trade. But remember that it is also a good as any other, subject to supply and demand!

In today's society, money is created by private banks through loans that they extend[2]. Money supply is indirectly regulated by the central bank though, via financial market operations. On the other hand, money demand is determined by how much of it people need to trade. Indeed, if we were all self-sufficient, we would have no use of money, and it would have no value for us.

Money value is not intrinsic: it varies according to demand and supply. Contrary to other goods for which a change in value has a limited impact on the rest of the economy, a change in money value affects deeply the whole economy, since all prices are expressed through money!

For example, if money supply doubles, then money value halves. Hence 1€ is worth less than before and, to compensate this loss in value, all prices are going to double. This is what's called *inflation.* More precisely, we speak about *nominal inflation* in this case, to stress the fact that the price increase is due to a value decrease of money, not to an increase in the good's value (this latter case would be an occurence of *real inflation*).

In our example, meat price is going to double. But did meat demand and supply change? No, this price increase is misleading because only price scale has changed, not meat value; we just express this value in a different unit. It is as though we started to measure distances in centimeters instead of meters: a measure of 2 m is identical to 200 cm even if the associated numbers, 2 and 200, are very different. This is why we don't like nominal inflation: it misleads us about value by changing the way it is measured. This effect is shown in the graphics below.

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[2]See more about it in the publication "D'où vient l'argent? — Comprendre notre système monétaire" on http://monnaie.ploc.be, yet untranslated.
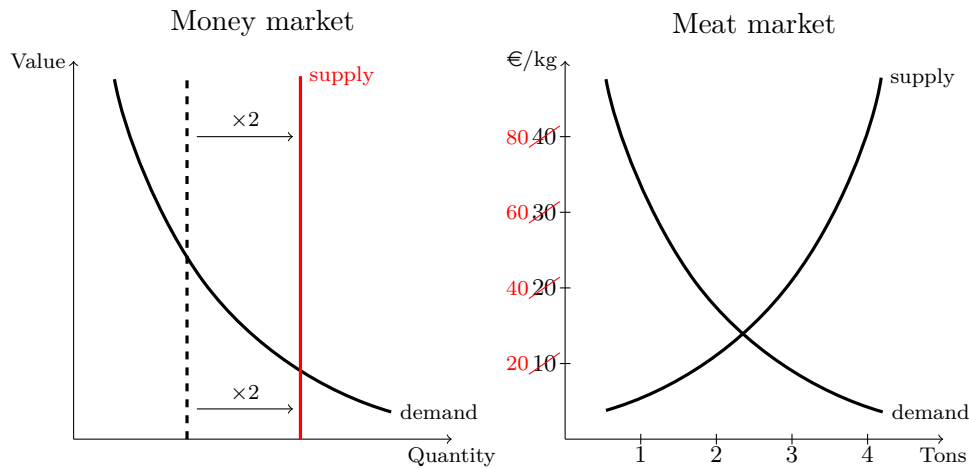
This makes us see that vertical axes in the above graphics shouldn't stand for price, but for value of the considered goods, as we did for the graphic about money. This would help us ignore nominal inflation, even though talking about prices is more natural. A solution to this issue is discussed in section 3.2.

# 3 Foundations of the relative theory of money

## 3.1 A neutral currency

If the euro disappeared today, we would all of a sudden be deprived of a fantastic trading tool and would be facing great difficulties. This situation would be particularly uncomfortable and new initiatives would rapidly flourish in order to set up a new currency. Starting from scratch offers a unique opportunity: instead of just reproducing legacy systems, we could take time to think of new ways to design this new currency. Let's see how we could do.

Let's assume we want to choose a good that will serve as money. Which one should we use? Gold or silver as in the past? Another (not so) precious resource? Making such a choice is problematic in that we would necessarily advantage producers of this good, who would then be able to influence supply as they see fit. They can indeed decide when to supply their production, who can access it by selecting their clients and even restrict supplied quantities on purpose, in order to push the prices up. This is what happens today: private banks can decide on when and who can have the money they create by extending loans to one person instead of the other and at one time instead of another.

We come to the conclusion that, if we don't want to advantage particular individuals, we must create a *new* good entirely devoted to easing trade, and that would be *neutral*, in the sense that its production would be run by all, and so not favouring anyone. The only way to treat everyone equally is to ensure that everyone can benefit in an equal way from money production. A fundamental observation of the relative theory of money is that this distribution should not only be equal among living people, but also through time! There is indeed no reason that our ancestors or descendants benefit more from money production than us.

Furthermore, since the value of money varies with time (see previous section), we should ensure that every past, present and future individual can benefit, not from the same quantity of money, but from a share *equal in value*.

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Hence, a fair currency would be a new good, coproduced by everyone through time, from which any past, present and future individual benefits in equal value.

> 🛈 **Choosing a good for money is not neutral**
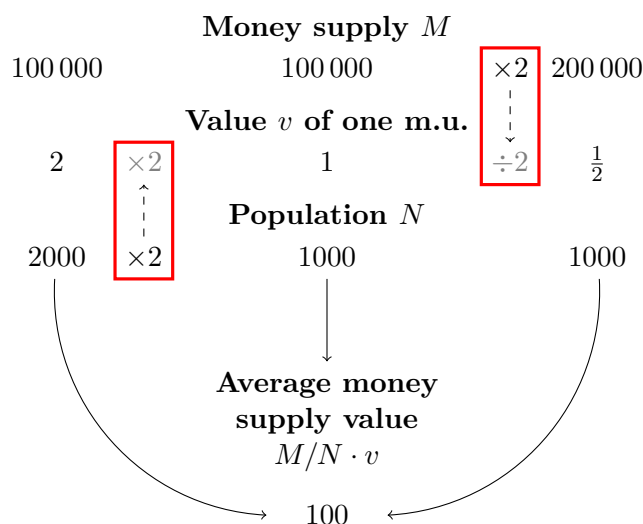> Graphical example with 3 goods.

## 3.2 An invariant value

In order to give sense to the expression "equal value", we seek in this section to determine a quantity of money, which may vary through time, but whose value stays the same. We'll say that the value of this quantity is *invariant*.

We saw in section 2.3 that two factors have an influence on money value: the total quantity in circulation (also called *money supply*), which we'll denote by the letter $M$, and people's needs in money. Those needs are hard to quantify, but we can safely assume that they directly depend on the number of people in the community, which we'll denote by the letter $N$ : if the number of people doubles, there should be about twice as much trade, so money should be worth twice as much, since demand has doubled.

The *average money supply* is then the quotient $M/N$. This is the quantity of money that every individual is entitled to if it was equally distributed. For instance, if the money supply $M$ amounts to 100 000 and there are 1000 people around ($N = 1000$), the average money supply amounts to $100\,000/1000 = 100$.

We claim that the quantity of money $M/N$ actually holds a constant value, whatever $M$ and $N$. Indeed, if $M$ increases, then the quantity $M/N$ increases, but the value of a monetary unit (shortened as m.u.[3]) decreases as much, making up for the increase in quantity. Similarly, if $N$ increases, then the quantity $M/N$ decreases, but the value of one m.u. increases proportionally, cancelling the decrease in quantity. This behaviour is illustrated by the following diagram:

**Money supply $M$**

| 100 000 | 100 000 | $\times 2$ | 200 000 |

**Value $v$ of one m.u.**

| 2 | $\times 2$ | 1 | $\div 2$ | $\frac{1}{2}$ |

**Population $N$**

| 2000 | $\times 2$ | 1000 | 1000 |

**Average money supply value**
$$M/N \cdot v$$

100

Consequently, someone who possesses 0.2 times the average money supply $M/N$ today would be equally rich moneywise than someone who possesses 0.2 times $M/N$ in 10

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[3]For instance, 1 m.u. would be 1€ in the eurozone.

years time. On the other hand, we cannot compare the monetary wealth of two people possessing 1000 m.u. through time, since the value of these m.u. can greatly vary according to the time considered.

> ### 💡 Clarifying prices
>
> We saw in section 2.3 that a price increase can be attributed to a change in demand or supply (we then speak of real inflation), but can also reflect a change in value of the monetary unit m.u. (this is nominal inflation). How to work this out? By expressing prices not in m.u., but in average money supply! If 1000 m.u. amount to 0.1 times $M/N$ today, these same 1000 m.u. might amount to only 0.07 times $M/N$ in 10 years time. They will have lost value, and prices will increase to make up for this loss. On the other hand, a bread worth 0.1 times $M/N$ today will be worth as much in 10 years, provided that the same level of demand and supply hold, since the value of $M/N$ doesn't change! If we notice that the same bread sells now at 0.2 times $M/N$, this is purely due to real inflation.
>
> Prices expressed in monetary units, as we do today with the euro, are referred to as *quantitative* prices. A price expressed in average money supply $M/N$ is said to be *relative*. Only the latter price reflects the value unambiguously.

We finish with an important remark. Although the value of the average money supply $M/N$ stays unchanged whatever $M$ and $N$ are, the quantity of money it amounts to varies greatly. Hence, if 100 m.u. amount to $0.1\,M/N$ today and the money supply $M$ doubles tomorrow, then since $0.1\,M/N = 0.05\,(2M/N)$, those same 100 u.m. will be only worth 0.05 times the new average money supply: they will have lost value. To make up for this loss in value, prices will increase to 200 m.u.

## 3.3   Fair money distribution

We thus decide to create a new good serving as money, and to share out the production fairly in value among past, present and future people. It is easy to do so when this good is first created: we only have to share out the created quantity equally among living people. That way everyone gets the average money supply. If the community wasn't meant to evolve over time, i.e. no birth will take place (they are all sterile) and no immigration is possible (they are completely isolated from the rest of the world), then we'd be fine. Money has been created fairly, and there is no reason one would want to create more. It gets trickier when we have to deal with new population members: they have to be provided with the same value of money than the others were at the beginning.

A way to solve this is to give the average money supply to every new member. In this case, if the number of individuals goes from $N$ to $N + 1$, then the money supply goes from $M$ to $M + M/N$ (a quantity $M/N$ is created for the new member), so that the new average money supply becomes

$$\frac{M + M/N}{N + 1} = \frac{(NM + M)/N}{N + 1} = \frac{M(N + 1)/N}{N + 1} = \frac{M}{N}.$$

It didn't change! That way, the monetary wealth of the first members stays the same: if an individual possessed — after some economic activity — 2.5 times the average

money supply $M/N$, then he still possesses 2.5 times the new average money supply $\frac{M+M/N}{N+1} = M/N$.

⚠️ One should consider the argument carefully here. Of course, new money was created when the new individual arrived. As $M$ increases, the value of the money decreases. But the presence of this new individual makes the demand in money go up, which increases its value! These two effects cancel each other, so that existing stocks actually don't lose any value.

This approach is all right but has some drawbacks. We saw that the monetary wealth of the individuals doesn't change when the community creates new money to welcome its new members. But what happens when someone dies or just leaves? In this case, the number of people $N$ goes down, and $M/N$ goes up. Therefore, the monetary wealth of each individual goes down, except for those who will inherit from the accumulated money of the deceased, which will (partly) make up for their losses! In particular, someone who would never get any inheritance would see her money stock lose value through her lifetime. But as we would only get our money share at the beginning of our lives, we would naturally keep it and spread its spending. This situation would make our money stock particularly sensitive to demographic uncertainties, and would penalize those who live longer. And yet we could argue that if one should be treated differently according to how long one lives, those who live longer should be better off...

**Permanent coproduction**

As an alternative, the relative theory of money suggests to regularly create new money, which will be equally shared by all individuals at all times. We further analyze this idea.

Since we are going to regularly create new money, the money supply $M$ will increase through time. We thus have to enrich the notation in order to easily track the evolution of the money supply as the years go by. To fix the ideas, let's take 2015 as base year. In mathematics, we usually refer to the starting point by the number "0". So if we write $M(0)$, we really mean "the money supply at the initial time", that is, in our case, in 2015. If we measure time in years, the symbol $M(1)$ then means "the money supply one year after the initial time", that is, in 2016, and so on. More generally, $M(t)$ represents the money supply $t$ years after 2015, where we chose the symbol "t" because it relates to time, according to mathematical custom.

We represent similarly the number $N$ of individuals in our community by the symbol $N(t)$, to indicate that this number evolves through time.

Each individual will receive each year a same share of new money. We want that the value of this share is invariant through time, so that no generation would be better off than another. As we previously saw in section 3.2, this means that each individual must get the same amount of average money supply $M/N$. We'll denote this number by the letter $c$. The quantity $c\frac{M}{N}$ is then called *universal dividend* and is denoted by $DU(t)$, where the symbol $t$ hints to the fact that this quantity may vary through time, even though its value stays equal.

Let's see how it goes through an example. In 2015, the money supply amounts to $M(0)$. On January 1st 2016, $N(1)$ individuals make up the population, and each of them

gets $c\frac{M(0)}{N(1)}$. Hence, the money supply increases by

$$N(1) \cdot \left(c\frac{M(0)}{N(1)}\right) = cM(0)$$

and we have

$$M(1) = M(0) + cM(0) = (1+c)\,M(0).$$

We can of course repeat the argument for the following year: in 2017 each one of the $N(2)$ individuals will get $c \cdot \frac{M(1)}{N(2)}$ and the money supply will rise to

$$M(2) = M(1) + cM(1) = (1+c)M(1) = (1+c) \cdot \left((1+c)M(0)\right) = (1+c)^2 M(0).$$

More generally, each individual gets the universal dividend $DU(t) = c\frac{M(t-1)}{N(t)}$ at the beginning of the year $t$ (we'll also say that she *coproduces* the money), the money supply increases of $c\,M(t-1)$ and we finally get

$$M(t) = (1+c)^t M(0).$$

This relation makes up the mathematical core of the theory.

Graphically, the money supply evolves as follows, where black dots indicate points belonging to the graphic and white dots indicate points that don't.
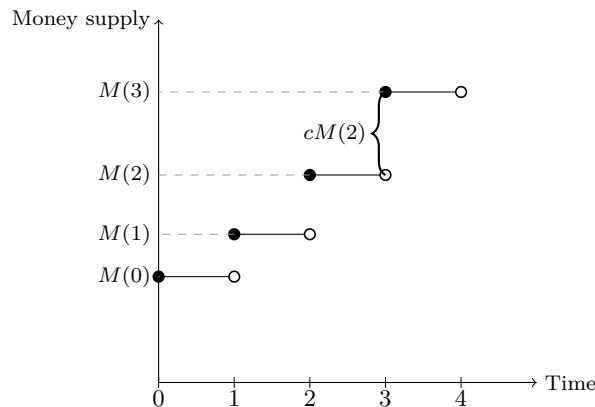


### The number $c$

The number $c$ is fixed once and for all when the currency is first set up. The choice of this number depends on the specific context of the community, and influences the currency's properties, as we will see in greater detail in section 3.7.

## 3.4   Economic liberties and terminology

Let's already observe that the discussion of the previous sections is based on a unique premise: everyone is free to grant value to things around them as they see fit (see liberty 2 below). From this follows that money should be a neutral good and that its production should not advantage anyone in particular, past, present and future. Each individual should therefore benefit from a share of equal value, whatever the time he lives in.

More generally, S. Laborde states 4 fundamental liberties that every economic system should satisfy in order to be really considered as free. These are:

0. *The individual is free to choose their monetary system*: Every individual has the right to choose in which currency they wish to trade (provided that, of course, this system is also accepted by the other party).

1. *The individual is free to use natural resources*: We have to keep in mind here that this freedom of use for all implies that no one has the right to monopolize these resources and to prevent the others to access them (see box below).

2. *The individual is free to produce and to grant value to any material or immaterial thing as they see fit*[4]. This liberty is the more fundamental of all; the whole reasoning of the RTM rests on it.

3. *The individual is free to trade in the currency.* In other words, she can express value, compute, record accounts and so on in the monetary unit that she adopted thanks to liberty 0.

A currency that satisfies these principles is then called *free*. Hence, a currency which grants a universal dividend as presented in the previous section is a free currency.

Although only liberty 2 is really used in the RTM, it is useful to keep in mind the other liberties, which allow to put our economic choices into perspective. For instance, using gold as money not only violates liberty 2, but also conflicts with liberty 1: this special role granted to gold encourages people to monopolize and stockpile it to the detriment of future generations.

> 🛈 **The notion of freedom**
> It is important to recall here that freedom is no limitless right and ends where it may harm others. We adopt the following definition: *freedom is the possibility that an individual possesses to act according to its own desires as long as this action does not harm other past, present and future individuals.*

## 3.5   Evolution of the individual monetary production

We take now a look at the evolution of the monetary wealth of an arbitrary individual — let's call him Igor — through his lifetime. We will make two assumptions:

1. the total population $N$ stays stable through time. In other words, if someone leaves the community, someone else enters to make up for the loss.

2. Igor's monetary flows are zero: if he earns money in some other way than through the universal dividend (he could work for example), this money is entirely spent, and nothing more is spent. Consequently, the only money that grows his stock comes from the universal dividend.

The first question that we will examine is: what quantity of money has Igor stocked up after benefiting from the universal dividend for $n$ years?

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[4]S. Laborde states it as follows: "The individual is free to produce any value." We find it useful to specify the statement.

Since each individual gets exactly $1/N$th of the monetary creation each year, after $n$ years Igor has coproduced

$$\frac{1}{N}\Big(M(t) - M(t-n)\Big),$$

if we currently are in year $t$. Since $M(t) = (1+c)^n M(t-n)$ (by the same argument as in 3.3), we have

$$\frac{1}{N}\Big(M(t) - M(t-n)\Big) = \frac{1}{N}\Big(M(t) - \frac{M(t)}{(1+c)^n}\Big)$$
$$= \frac{M(t)}{N}\Big(1 - \frac{1}{(1+c)^n}\Big).$$

Therefore, after receiving the universal dividend for $n$ years, Igor possesses $1 - \frac{1}{(1+c)^n}$ times the average money supply. As $n$ grows (we say that $n$ *tends towards infinity*), $(1+c)^n$ gets larger, thus $1/(1+c)^n$ gets closer to 0. We conclude that the quantity of money accumulated by Igor tends to the average, $M(t)/N$ as the years go by.

Let's now assume that Igor dies after 80 years of existence. In this case, he will have accumulated a quantity

$$\frac{M(t)}{N}\Big(1 - \frac{1}{(1+c)^{80}}\Big)$$

of money the day of his death. After $n$ years after his death, the money supply will amount to $M(t+n) = (1+c)^n M(t)$. Consequently, this money stock will have lost value since it didn't change while new money was created. More precisely, the fraction of the money supply it amounts to after $n$ years equals
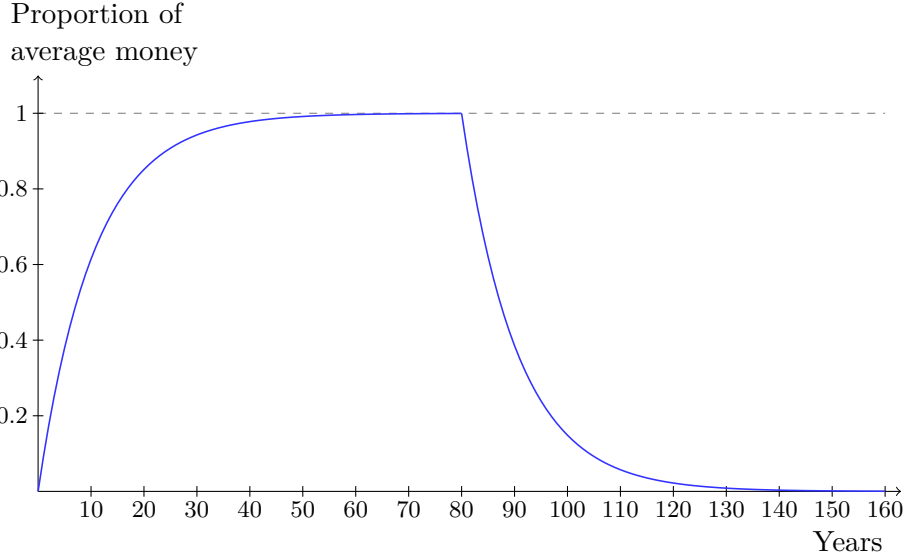
$$\frac{\frac{M(t)}{N}\Big(1 - \frac{1}{(1+c)^{80}}\Big)}{M(t+n)/N} = \frac{\frac{M(t)}{N}\Big(1 - \frac{1}{(1+c)^{80}}\Big)}{(1+c)^n\, M(t)/N}$$
$$= \frac{1}{(1+c)^n}\Big(1 - \frac{1}{(1+c)^{80}}\Big)$$
$$= \frac{(1+c)^{80} - 1}{(1+c)^{n+80}}.$$

As $n$ grows, $1/(1+c)^{n+80}$ gets closer to 0, what drives the stock value to 0. These results are illustrated below.[5]

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[5]We use here a value of 10% for $c$, which seems to be a sensible choice (see section 3.7).

As we see, the money possessed by Igor grows through his lifetime up to a level very close to the average money supply. Upon his death, Igor gets no more universal dividend to make up for the loss of value of his stock, and this stock loses value down to almost nothing.

More generally, we can examine how Igor's money stock evolves if we assume that he doesn't start with no money at all, but already possesses some money in the beginning, which could for example have been acquired through inheritance. More precisely, let's assume that Igor possesses a fraction $s$ of the average money supply at time 0, and let's see how the value of this stock evolves after $n$ years of coproduction. Igor possesses $n$ years after time 0 a quantity of money equal to

$$\underbrace{s \frac{M(0)}{N}}_{\text{initial stock}} + \underbrace{\frac{M(n)}{N}\Big(1 - \frac{1}{(1+c)^n}\Big)}_{\text{coproduced quantity}}.$$

In order to know its value at time $n$, we divide by the average money supply $M(n)/N$:

$$\frac{sM(0)/N}{M(n)/N} + \Big(1 - \frac{1}{(1+c)^n}\Big) = \frac{sM(0)/N}{(1+c)^n M(0)/N} + \Big(1 - \frac{1}{(1+c)^n}\Big)$$

$$= \frac{s}{(1+c)^n} + 1 - \frac{1}{(1+c)^n}$$

$$= 1 + \frac{s-1}{(1+c)^n}.$$

Hence, since $\frac{1}{(1+c)^n}$ tends to 0 as $n$ gets larger, the value of the stock converges to the average $M/N$, whatever $s$! We can distinguish 3 cases though:

1. if $s$ is greater than 1, then the value of the stock tends to the average, but is always higher;

2. if $s$ is less than 1, then the value of the stock tends to the average, but is always lower;

3. if $s$ is equal to 1, then the value stays constant and is always equal to the average.

This result is summed up in the following graphic:
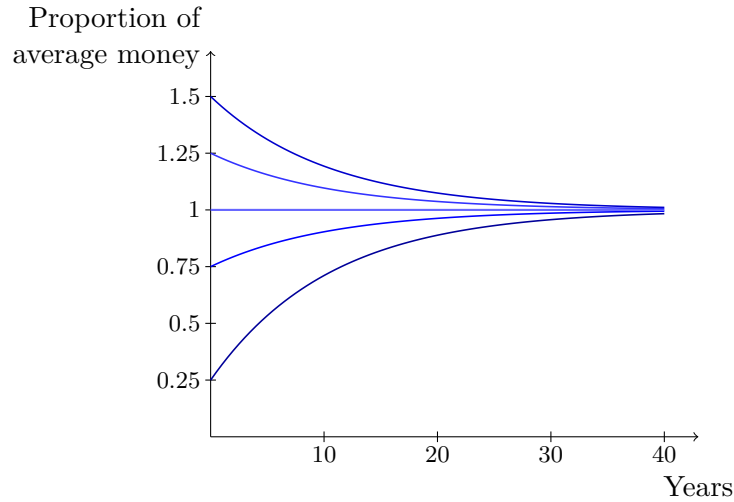


## 3.6   Inflation and money depreciation

**Inflation**

As we saw, the relative theory of money suggests to increase the monetary aggregate at a constant rate $c$. Knowing so, some critics point out its inflationist pressure. We argue that the optimal suggested rate (around 10%, see section 3.7) is actually very close to the growing rate of the money supply today. On the other hand, one advantage of the RTM is that this rate is fixed once and for all and becomes thus *entirely controlled and predictable*.

But even though it is controlled, the inflation of the money supply will induce a nominal inflation of the prices (see section 2.3), which is still very annoying to manage. To ease this, the RTM suggests to express the prices, not in absolute quantities of money (*quantitative* point of view), but in proportion of the average money supply, which holds a constant value (see section 3.2). Every price change would hence be entirely due to changes on the good's market, and not to money.

In order to get a better intuition on the actual value of the average money supply $M/N$, it is suggested to express prices in universal dividends $cM/N$ instead, which have a more concrete value for people.

**Depreciation**

A related criticism is that a currency that follows the principles of the RTM depreciates over time, that is, it loses value. This depreciation is due to the programmed growth of the money supply.

This is true: money stocks lose value each year (provided that the population doesn't grow too much to compensate money supply growth though). But this decrease in value is *compensated* by a regular supply in new money. This point is crucial! Taking this supply into account, we saw in section 3.5 that this depreciation only affects those who

already possess more than the average money supply. People possessing less than the average, will even gain more than they had before!

This is very different from the usual notion of depreciation, where an individual's stock of money with no monetary flows would eventually lose all its value. In the present case, the money stock of this individual will get closer to the average over time, wherever it starts: above or below average. Can we then really talk of depreciation?

Finally, let's remark that the money supply growth has also a very positive side effect: the value of the money coproduced by people now dead, which has lost its relevance, loses value over time.

**Another point of view on monetary inflation**

A key fact to understand is that inflation due to money growth is actually a type of wealth reallocation. The monetary stocks of *every* individual lose value, while the wealth of *some* individuals, those who get the newly created money, gets larger. Another relevant point of view is to consider that the addition of value that comes from the newly created money is compensated by a loss of value of the previously existing money. We are thus dealing with reallocation. This reallocation is by nature very soft since it doesn't involve seizing some individual's property and giving it to others. The simple fact of giving money to some eats everyone's wealth away.

In the current system, the main part of the benefits coming from monetary creation is monopolized by private banks via the interest rates they charge on loans, whereas inflation that ensues affects the whole population.

In a monetary system with universal dividend, this reallocation is by nature the fairest possible, since every individual gets the same monetary value. Following this, we claim that inflation induced by the RTM, besides being of comparable magnitude to what we know now, offers a few advantages:

1. it advantages no one: the stocks of *every* individual gets larger beside losing value.

2. it is entirely controlled, since programmed beforehand. There is hence no risk of abuse by the issuer[6].

Just as reallocating wealth too aggressively is not sensible, monetary supply shouldn't grow too fast. Since the growth rate is determined by the factor $c$ of the universal dividend, this factor should be chosen carefully. This is the subject of the next section.

## 3.7 How to determine a good coefficient $c$

We ask now: what should we take for $c$? The answer is pretty simple: it all depends on the context and goals we set for the currency. We give some ideas in what follows.

Let's again consider Igor's case, our individual with zero monetary flows. We still assume that our population is constant and equal to $N$ (see assumptions of section 3.5).

We saw in section 3.5 that the quantity of money accumulated at time $t$ by Igor after $n$ years amounts to

$$\frac{M(t)}{N}\Big(1 - \frac{1}{(1+c)^n}\Big).$$

---

[6]Historically, states have often been tempted to produce more money than is sensible in order to cover their expenses, what led to hyperinflation crisis in extreme cases. This is why central banks are now independent from the government.

Therefore, the larger $n$ gets, the closer this quantity comes to the average money supply, but without ever reaching it: the fraction $\frac{1}{(1+c)^n}$ will never be zero.

We plot some curves below showing how this stock evolves for different values of $c$, in order to understand how these different values affect Igor's level of wealth through his lifetime.
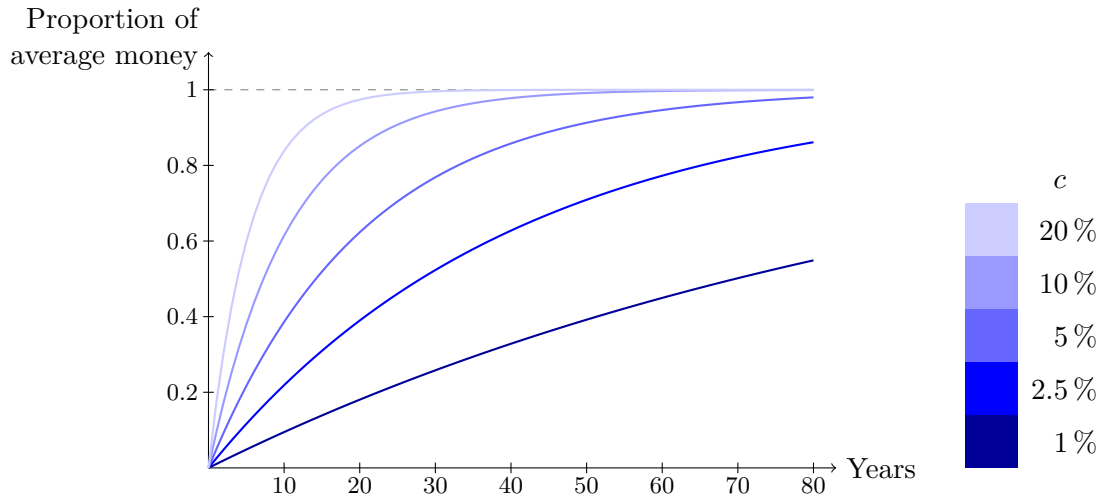


Observe that the larger $c$ is, the faster Igor's wealth will tend to the average. Can we conclude that $c$ should be as large as possible? No! A large $c$ has also a pernicious effect: it depreciates existing stocks faster, what will discourage saving. This will favour people who possess less than the average to the detriment of those above average. It all boils down to finding the right balance.

Stéphane Laborde argues in two steps as follows to suggest a good value for $c$. Assume that a newborn's life expectancy is 80 years. The first step of the argument goes as follows. We saw in 3.3 that each individual should have right to the average money supply throughout their life. If they just stockpile the money they coproduce, then this stock gets closer and closer to the average. An individual should thus get a proportion of the average money supply close to 1 at the end of 80 years life. This can be written down as

$$\frac{M(t)}{N}\left(1 - \frac{1}{(1+c)^{80}}\right) = \alpha\,\frac{M(t)}{N},$$

with $\alpha$ close to 1. Solving for $\alpha$ we get

$$\alpha = 1 - \frac{1}{(1+c)^{80}}$$

and we deduce that

$$\frac{1}{(1+c)^{80}} = 1 - \alpha$$

$$\Leftrightarrow (1+c)^{80} = \frac{1}{1-\alpha}$$

$$\Leftrightarrow 1 + c = \sqrt[80]{\frac{1}{1-\alpha}}$$

and eventually

$$c = \sqrt[80]{\frac{1}{1-\alpha}} - 1.$$

In particular choosing $\alpha$ entirely determines $c$. But what should we take for $\alpha$? 90%? 99%? 99.99999%? These choices give values for $c$ as different as 3%, 6% and 22%.

For a fixed $\alpha$ (we still have to choose it!) we'll say that an individual who accumulates $\alpha M(t)/N$ has *reached their full money share*. Hence, the relation $\alpha = 1 - \frac{1}{(1+c)^{80}}$ shows that we wish that this full share is obtained after 80 years life. We could also choose to reach it sooner, as we'll later see.

In this case all individuals reaching their full money share on a given year are in proportion 1/80 of all people having reached this full share for the last life expectancy (if 100 people reach their full share each year, $80 \times 100$ have reached it for the last 80 years. This year's 100 people represent thus 1/80 of all 8000 people from previous years). We hence take $\alpha = 1 - \frac{1}{80}$, and doing so, money's fading away is modelled on humans fading away. This gives an annual rate $c$ of $\sqrt[80]{80} - 1 = 5.6\%$.

Stéphane Laborde then notices a few things. At first, it would be more useful for an individual to obtain their full money share after 40 years instead of 80. Furthermore, since an individual could actually enter the community at any time in their life, their life expectancy is only 40 years on average, and not 80. Hence, if we want that an individual gets their full money share after 40 years in the community, we set $\alpha = 1 - \frac{1}{(1+c)^{40}}$ and $c = \sqrt[40]{\frac{1}{1-\alpha}} - 1$ since we now only have to consider 40 years of accumulated money in order to determine the rate $\alpha$.

Once again, all individuals who reach their full money share on a given year represent $1/40^{\text{th}}$ of the individuals who have reached it for the last 40 years, hence we choose

$$\alpha = 1 - \frac{1}{40} \quad \text{and} \quad c = \sqrt[40]{40} - 1 = 9.7\%.$$

More generally, Stéphane Laborde suggests a rate $c$ equal to

$$\sqrt[\frac{\text{le}}{2}]{\frac{\text{le}}{2}} - 1$$

where le denotes a newborn's life expectancy[7].

This heuristic argument does not claim that these values are better than others. Only a test in real conditions can give us a clue.

Observe at last that choosing the year as time unit has a fundamental impact on the recommended value for $c$. The whole argument expressed in months would give a life expectancy of $80 \times 12 = 960$ months and we'd get a *monthly* rate of

$$c = \sqrt[480]{480} - 1 = 1.3\%.$$

Stéphane Laborde advocates the use of years because our trade is highly related to annual cycles (annual accounts, school years, etc.)

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[7]This expression can be approximated by $(\ln \frac{\text{ev}}{2})/\frac{\text{ev}}{2}$ using Taylor expansion.

## 3.8   Working out popular slogans

**Money supply doesn't change**

Of course, money supply does change all the time in quantity, but its value doesn't change if the population $N$ doesn't either. Indeed, in this case, the money supply $M$ is still worth $N$ times the average money supply $M/N$, whatever $M$. And we saw in section 3.2 that $M/N$ holds constant value.

**Money doesn't depreciate**

We saw in section 3.6 that a currency with universal dividend doesn't depreciate in the usual sense, because the universal dividend compensates the loss of value of money stocks. The money stock of an individual with zero money flows will therefore converge to the average money supply, and not to 0 as would happen if the money really depreciated over time.

## 3.9   Population changes

Up to now we argued under the assumption that the population was stable. This assumption shouldn't be a problem in practice since our populations grow at low rate. But many things happen when population evolves.

To complete...

## 3.10   Some practical issues

Loans, exchange rates, spreading of the universal dividend...