the par price feedback mechanism

Context: Why invent words?

Why invent new terms? The reason is that many terms in the financial world are heavily overloaded – one word means many different things.

One especially problematic term is “rate”. This can mean the interest rate as is traditionally understood, which we call **`fee`** or the “quantity rate”. But there is also the “price rate” (**`way`**), which is the primary monetary lever in the system. There is also the *effective rate of borrowing*, which combines the two, and is the one that actually matters for borrowers. Rate can also mean the rate of change of any of these (like **`how`**, the sensitivity parameter for **`way`**).

By inventing new words, it forces you to confront the *actual mechanics*, rather than adopt hidden assumptions. In my experience, this makes a real difference. There are so many subtle variations that more often than not people will think they are talking about the same design, when really they aren’t. It turns out to be easier to start from a tabula rasa, by inventing new symbolic terms, and ensuring you agree on definitions from the beginning, without any connotations.

Context: Multiplicative form

One common error when working with interest rates is adding and subtracting rates when they are expressed as percent differences. It is tempting to think that 2% + 3% = 5%, or that the opposite of 5% is -5%.

The right way to think of rates is like scaling factors. The opposite of **`+5%`** is actually roughly **`−4.76%`**. That’s because the inverse of **`1.05`** is **`1 / 1.05`**, which is roughly **`0.9524`**.

When we say “rate of change of a price”, we mean an exponential growth rate, not a linear slope. This has a subtle but important consequence for designing control systems for **`way`**: all derivatives are directly proportional. There is only one variable to control when designing a controller for **`way`**, the only question is *how* is it adjusted.

Definitions

Here are the definitions of the core terms used in vox.

- **`REF`**: The external reference asset. It is written in capitals like a ticker because it is a symbol, not a number. An external reference asset could be `USD` or `XAU`.

- `par`: The system's internal definition of the price of the synthetic, in terms of the external reference asset.
- `way`: The annualized growth rate of `par`, like an interest rate that is built into the price of the synthetic.
- `fee`: The interest rate as is typically understood, a growth in the *quantity* of `par` owed, expressed as annualized growth rate.

In the past we used the terms "target price" or "redemption price" for `par`, but these are both slightly misleading. "Redemption price" implies the synthetic is redeemable for `par` units of `REF`, but this is not accurate, the credit unit is not redeemable for anything, it gains its value entirely from being able to cover debt denominated in the same unit. "Target price" is a bit better, but some people infer this means that the system is *always* targeting that price, when in fact `par` is a "moving target". Now we simply say "par price", we found it seems to have the fewest existing connotations.

`way` represents a transfer of value between the borrower and the holder of the synthetic. `fee` represents a transfer of value between the borrower and the system - the "central bank".

Our claim is that `way` should be the lever for monetary policy, and can be adjusted in a formulaic way, while `fee` is a per-collateral-type risk parameter, like an insurance fee, and should not be used as a monetary lever. Central banks get trapped by the 'zero bound' when they abandon the use of an external reference asset, which leaves only the `fee` as a policy tool. But this interferes with the function of `fee` as the insurance fee.

Mapping value flows onto a more familiar model:

Where a bank might offer a savings rate, this is instead realized directly via `way`. The spread between savings and borrow rate is analagous to `fee`. Where a bank charges a borrow rate, this is the *sum* of `fee` and `way`.

The key is that in a traditional system, to have a negative borrow rate while balancing debt and credit, the central bank must transfer a *quantity* of units to the borrower, which must be obtained somewhere. This means either the bank has reserves, must print credit from thin air, must dilute and sell its equity, *or it has to take credit units from holders*. This last point is what some use to advocate for cashless systems and the ability for the central bank to take quantities of credit units from holders.

There is another way to have effective negative borrow rates: use `way`. If `way` is "more negative" than `fee` is "positive" (for example, `way = 0.95, fee = 1.02`), then the effective rate of borrowing is negative: You can borrow, buy **`REF`**, and even though you will owe more credit units, the total value of your debt will have dropped relative to the amount of **`REF`** you own. At the same time, the bank still has positive cashflow. If **`fee = 1.02`**, then at the end of the year it will have 2 extra units. Those units might be worth less than they were at the start (if **`way < 1`**), but this doesn't change the fact that it still had revenue (compared to **`fee < 1`**, where the bank would have a loss).

!! Another key point to emphasize is how the interest is "created" in real time as it accrues, and is circulated into the economy (via buy/burn, or however else) *at the same time that the debt grows*. This mechanic is crucial to ensure that the system debt and credit are balanced. A naive solution causes *more debt to exist than credit units*, which leads to a sort of infinite debt treadmill that requires ever-growing loans to sustain, and is never repayable.

Examples – fixed `way`

This initial examples describes a scenario where **`way`** is constant, to help demonstrate how **`way`** and **`fee`** together impact the effective rate of borrowing. In the real systems **`Vox`** automatically adjust **`way`** in real time, based on the difference between **`par`** and the observed market price of the synthetic. Different methods of adjusting **`way`** correspond to different types of synthetics. They can be perp-like, bond-like, fiat-like, and likely many more. These are described later in the **`vox types`** section.

`fee > 1, way = 1`

Let's start with something familiar. You borrow $100 from the bank at 5% interest. One year later, you owe $105. To keep the system balanced, principal cancels out debt, and interest is re-circulated. Note in this example it is not possible to cover all the debt – we will revisit this later and explain how this is addressed in a properly balanced system).

In this example,

- **`REF`** is **`USD`**
- **`par`** is 1.0
- **`way`** is 1.0
- **`fee`** is 1.05

We call **`fee`** the "quantity rate" because the *quantity of units owed* has changed. There is a net transfer of 5 units from the borrower to the lender. The price of the unit has not changed, because we are dealing with the external reference asset directly. 1 dollar is 1 dollar.

`fee = 1, way > 1`

Another way to represent equivalent value flows is with a kind of “receipt” which represents a variable quantity, but does not actually result in a transfer of units.

- **`REF`** is **`USD`**
- **`par`** is 1.0
- **`way`** is 1.05
- **`fee`** is 1.0

`fee < 1, way = 1`

You can also imagine a system where **`fee`** is negative. Remember we are using multiplicative form, so “negative” actually means “less than 1”.

- **`REF`** is **`USD`**
- **`par`** is 1.0
- **`way`** is 1.0
- **`fee`** is 0.95

A negative **`fee`** means there is a net transfer from the lender to the borrower. You borrowed $100, but you only owe $95. *This is the situation that is not viable in a system where cash exists.* It requires the central bank to either print unbacked money, have potentially unlimited reserves, or *take quantities of asset from people’s savings*.

Instead, an economically equivalent result can be achieved with **`way < 1`**.

`fee = 1, way < 1`

…

`fee > 1, way > 1`

This example represents the familiar situation where both the borrow rate and savings rate are positive. Here **`way`** is like the savings rate, **`fee`** is like the spread, and **`way * fee`** is like the borrow rate.

`fee > 1, way < 1`

Finaly, the most interesting scenario is where **`way`** is “more negative” than **`fee`** is positive. This is the scenario where the *effective rate of borrowing* is negative – borrowers are incentivized to borrow, trade for REF, and the later trade back.

Controller examples

In these examples, we use the analogy of PID controllers, although it is important again to emphasize typically PID controllers use polynomials while these controllers use exponentials. To map these controllers onto PID model, you would operate on log-price and log-rate.

Simple “P” controller - like a perpetual swap

Simple “I” controller - like a fiat currency

“PI” controller - like Rai