

# Thinking about the MARR

This handout was written by Chris Willmore, and based on answers given to questions asked by students via e-mail in Fall, 2022.

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## A FEW SIMPLE EXAMPLES

It's perhaps easiest to explain if we step away from rates from a while, and just look at plain numbers.

Suppose someone wants to hire a teenager to babysit a child for four hours. How much must they pay the teen, in order for the teen to accept the work?

It depends on what other options the teen has for those four hours.

Suppose (to avoid the difficulties involved in finding a dollar value for sacrificed leisure time) that the teen was going to work during those four hours anyway, only cares about money (as opposed to, say, a nice work environment) and has the following options available:

- Mow grass for \$10 an hour.
- Work overtime at their part-time job for \$15 an hour.
- Work at an app-based gig economy job, which usually brings in about \$12 an hour.

If you want the teen to babysit for you, you have to pay them *at least* as much as they could get elsewhere. That means you need to at least pay them \$10/hr, or they'd rather mow grass, at least \$12/hr, or they'd rather do the gig economy job, and at least \$15/hour, or they'd rather work overtime at their part-time job.

Putting these constraints together, the one that ends up being binding is the highest-paying job among their alternatives, and the minimum acceptable hourly babysitting wage for our teen would be \$15/hour.

If instead we put things in terms of 'rates', the same applies.

Suppose you want someone to invest in your engineering firm's new project. Suppose the investor can do the following with the money you want them to hand over to your company:

- Put the money in a savings account which pays 1% a year in interest.
- Invest the money in another company's long-standing project with a known return of about 6% per year.
- Invest the money in provincial bonds, which pay 3% a year.
- If the money you're asking for is more than they have on hand at the moment, they may need to borrow most of it to pass on to you, and their cost of borrowing is 1.5% per year. By not investing this large amount of money in your company, they could avoid the 1.5% borrowing fee.

Then, in order to get them to invest in your company's project, ignoring uncertainty to keep things simple (chance of project failure, etc.), then you'd need to at least offer them a return of 1% a year, or they'd rather put the money in savings, at least 6% per year, or they'd rather invest in that other company's project, at least 3% a year, or they'd rather put the money in provincial bonds, and (if they'd have to borrow in order to pass it on to you) at least 1.5% a year, or they'd rather avoid the borrowing.

Altogether, the binding constraint is the one from the highest return in that list. You'll need to offer them at least 6% a year to get them to bite. That's the investor's minimum acceptable rate of return.

You can think about it in terms of FOMO (Fear Of Missing Out): what's the lowest rate that'll make the person suffer from FOMO?

In the case of the babysitter, anything less than \$15/hour, and they won't suffer from FOMO, since they have better options available "at home".

In the case of the investor, anything less than 6% a year, and they won't suffer from FOMO, since they have better options available.

## HOW CAN AN INDIVIDUAL HUMAN BEING HAVE A MARR?

It's not unusual for students early in the course to think that "MARR" is a specific term of art used to refer to some sort of calculated value (presumably via some

formula that hasn't been shared with you yet) that is only ever used by businesses, for very specific purposes, probably involving quarterly reports to shareholders.

That's not the case. The concept is extremely general, and for once, the acronym really is just a time-saver so the same few words don't have to be repeated over and over again.

From the instructor's point of view, the situation is akin to that of a student in a first-year physics course who, prior to the course, has only ever heard the term "mass" applied to inanimate objects, and after asking the professor a few questions and receiving a reply, says,

"Thanks for all those examples involving weight, but I still don't see how a human being can have mass."

This is a common, perfectly understandable mix-up - and one which is both easy and important to fix.

So, let's get to it. I'll go step by step, so I apologize in advance if that makes the exposition seem slow.

A "return" is what you get in exchange for sacrificing/using/giving up your resources.

If you're okay with losing a \$20 bill in a storm drain but ARE okay with exchanging that \$20 bill for a pizza, you have a minimum acceptable return for that \$20 bill.

(I'm intentionally not using the word "rate" yet. That comes in a bit later, below.)

If you're okay with spending 4 years using up most of your time, mental health, physical energy, money, and attention and getting, among other things, an engineering degree at the end, but are NOT okay with exactly the same situation except that you don't receive a degree at the end, you have a minimum acceptable return for that time, mental health, physical energy, money, attention, etc.

If you're okay with being woken up at 3 AM by a phone call from a close friend who needs to talk to you for 30 minutes for help dealing with a personal crisis, but are NOT okay with being woken up at 3 AM, and spending the same time talking to a telemarketer, then you have a minimum acceptable return on your 3 AM to 3:30 AM time, albeit one that is tricky to summarize in terms of universally accepted numbers.

If human beings did NOT have a minimum acceptable return for their resources, then we should be fine with everything we feel we have some claim to being snapped out of existence, Thanos-style.

In general, that's not the case, and there will be some minimum return on our resources that we'll be okay with. Anything less than that, and we won't willingly agree to giving up/using/sacrificing those resources, be they time, mental or physical health, a clean environment, an old growth forest, etc.

## SO, WHERE DOES THE "RATE" PART COME IN?

The "rate" is just a convenient unit of measure for the return, given the type of stuff that someone using the tools of engineering economics is likely to be looking at.

Any situation of the type, "Give up something now, in exchange for getting something later" can be summarized in terms of rates of return.

This is most obvious when that's literally all there is to the problem, and we're talking in terms of dollars, where sometimes it's possible to see even by inspection:

"Give me \$100 today, and I'll give you \$110 tomorrow" - a return of \$10 on \$100 sacrificed for one day, otherwise known as a rate of return of 10% per day.

"Give me \$1,000 ten years from now, and I'll give you or your descendants \$900, 110 years from now" - a loss, or negative return, of \$100 on \$1,000 sacrificed for a century, otherwise known as a rate of return of -10% per 100 years.

In general, if the situation is of the form,

- ✓ Sacrifice (pay) [COST]  
Get [INCOME], T time periods later

Then we can write

$$\begin{array}{ccc} 110 & 100 & 10 \\ \hline [\text{INCOME}] = [\text{COST}] + [\text{RETURN}] \end{array}$$

And in these very simple examples,

$$[\text{RATE OF RETURN}] = [\text{RETURN}]/[\text{COST}] \text{ per T time periods.}$$

So, in our first example,

$$[\text{COST}] = \$100$$

$$[\text{INCOME}] = \$110$$

$$T = 1 \text{ day}$$

$$[\text{INCOME}] = [\text{COST} + \text{RETURN}]$$

$$\$110 = \$100 + [\text{RETURN}]$$

$$\rightarrow [\text{RETURN}] = \$10$$

$$[\text{RATE OF RETURN}] = [\text{RETURN}]/[\text{RESOURCES}] \text{ per } T \text{ time periods} = \$10/\$100 \text{ per } 1 \text{ day} = 0.1 \text{ per } 1 \text{ day} = 10\% \text{ per day.}$$

Similarly, in our second example, this same procedure would lead to a rate of return of -10% per century.

If we wanted to compare these two directly for some reason, there are well-established procedures for putting them both in terms of % per year, or % per picosecond, or % per millennium, just as you can take speeds in terms of m/second and m/day, and turn them both into, say, an equivalent km/hour to be able to more easily compare them.

We'll be learning those techniques very soon.

If we're NOT talking in terms of dollars, the concept of a rate is less useful. It still applies, but may not be worth invoking due to the difficulties involved in communicating it to people (not agreeing on units for the value of an engineering degree, or for the value of sacrificed sleep, many of these units even if agreed upon not playing nicely with each other, etc.).

If we ARE talking in dollars, but the situation is more complicated than "give up \$X today and get \$Y some specified time later", there are well-established ways of finding a rate corresponding to the concept above, so long as the thing you're looking at is of the form "give up something, in exchange for getting back something later," (e.g. spend a whole bunch of time, work and money building a bridge in exchange for toll revenue later, or spend money on insurance premiums every month until you die, in exchange for your designated heir getting a big payout when you die), or "get something, in exchange for sacrificing something later (e.g. get a whole bunch of money from the bank now, in exchange for monthly payments to the bank for the next 25 years).

We'll be learning some of these "well-established ways" later in the course.

There are, of course, lots of projects that DON'T fall into that scheme - even the seemingly innocuous "half up front, half when the job is done" contract. The rate of return concept is... trickier in those circumstances, and arguably not as useful, but there are even ways of dealing with that, which we'll look at later in the course.

Still, enough projects and other opportunities look like "give up something to get back something else, later" that the "rate of return" makes a pretty darned good approximation to a universal unit that will allow a rigorous comparison of vastly different projects and opportunities.

It has the power to summarize what could be a hideously complicated stream of payments and income into a single number. Much like a nutrition facts label on fruits can allow you to compare the calories in apples and oranges directly. Calories aren't the ONLY thing people can or should care about when choosing between these fruits, nor are the other numbers listed on the nutrition facts label - but that label still covers enough points of interest that as a society we've decided it's worthwhile requiring them to be printed on most foods.

So, there you have it. The MARR is a measure of the smallest compensation you're willing to accept for the sacrifice of a resource at your command - your time, your mental health, your physical energy, etc. - phrased in a way that, in many cases of general interest, allows the simplified comparison of what could be vastly different opportunities for using those resources.

Businesses find this to be a very useful concept, for sure, but it's by no means a concept exclusive to them.



### WOULD A LIVING WAGE + A HEALTHY WORK/LIFE BALANCE BE A MARR?

While "a living wage and a healthy work/life balance" sounds like it should be the minimum requirement for any job one might consider, for many this is unfortunately more of a goal than a Minimum Acceptable Return for the sacrifice of their working hours.

A key implication of the existence of a MARR, is that it represents a threshold on how bad a deal you will accept; it allows you to say, "I don't have to be here, so if you offer less than this I'll walk away."

If you can truthfully say that, it is because you already have an option that offers "this" available.

If "a living wage + a healthy work/life balance" is someone's MAR (not rate of return, since it's not expressed that way, but minimally acceptable return), that would imply that they already has a fallback option that will give them all that, so anyone trying

to convince them to work for them, invest in them, etc. will have to at least match that.

Think of it in terms of job offers at a company. If you don't have any other opportunities line up, and you have bills to pay, you may be put in a position where you have to accept a terrible "take it or leave it" offer by the employer – perhaps even one without a living wage or healthy work/life balance.

If you have OTHER opportunities - say, if a company has ALREADY offered you a job with higher-than-average pay, great benefits, flexible hours, etc. - then any other employer wanting to hire you will have to at least match that. The best offer you have in the bag becomes your MAR for that specific job-seeking context.