

Your Stock Trading Game

by Guy R. Fleury

Your Stock Trading Game takes a look at trading stocks with a long-term perspective. It will use equations as a guiding light to higher portfolio returns. These equations will impose trading limitations as well as unleash a portfolio's long-term potential. If you do not plan your future or have no idea of where you are going, where do you think you will end up?

In my previous article, [Basic Portfolio Math](#), we were shown 3 basic portfolio equations, all giving the same answer. From a world of short-term quasi-randomness, you could extract long-term expectations, or at least some tools to estimate where it was all going based on your trading procedures and constraints.

You had choices to make from the start that would greatly impact the future outcome of your stock portfolio or retirement fund.

Here is a recall of those 3 equations:

$$F(t) = F_0 + \sum_1^N (\mathbf{H} \cdot \Delta \mathbf{P}) = F_0 \cdot (1 + \bar{r}_m + \alpha)^t = F_0 + N \cdot \bar{x}$$

The first part is the payoff matrix which accounts for the strategy's whole trading history. No matter how long you traded, or how many trades you made, it is all in the above payoff matrix. That you trade once or a million times, all of it is accounted for, to the penny.

The middle part says the same thing, but in terms of time and the portfolio's growth rate (CAGR). The market's long-term average return \bar{r}_m is applied to some initial capital F_0 over a period of time. The alpha (α) represents the added skills, or added return you bring to the game (whatever its origin), while t is the number of years it takes to get there. It is how long your trading strategy needs to survive.

Finally, the third part resumes it all in just two numbers: N the total number of trades executed over the life of the portfolio, and \bar{x} the average profit or loss per trade. $N \cdot \bar{x}$ has the same value as the payoff matrix: $\sum_1^N (\mathbf{H} \cdot \Delta \mathbf{P}) = N \cdot \bar{x}$. Rearranging the equation gives a simple understanding for the origin of \bar{x} : $\frac{\sum_1^N (\mathbf{H} \cdot \Delta \mathbf{P})}{N} = \bar{x}$, it is a simple average.

The portfolio's CAGR calculation :
$$\left[\frac{F_0 + \sum_1^N (\mathbf{H} \cdot \Delta \mathbf{P})}{F_0} \right]^{\frac{1}{t}} - 1 = \bar{g}$$

All 3 parts of the above equation will hold and equal each other's end results. Whatever the result of one part, it will force the other variables to comply, since each equation does give the same value.

Extract What You Can

We should extract as much information as we can since whatever we will do trading will end up within the confines of those equations. Whether it be in a simulation or trading live.

I prefer expressing the average portfolio growth rate \bar{g} as: $\bar{g} = \bar{r}_m + \alpha$. The long-term market average tends to its historical average: $\bar{r}_m \rightarrow 0.10$. It is almost given away for free.

You can get \bar{r}_m simply by buying and holding a low-cost index fund for the duration (index trackers like QQQ, SPY, or DIA). I have a preference for QQQ since it has a little alpha built-in.

It does put a minimum objective to what you have to achieve and exceed if you want to undertake the job of managing your own portfolio. You need to bring some positive alpha to the game.

Should $\bar{g} < \bar{r}_m + \alpha$, you will be underperforming the market, and the only reason for this would have to be attributed to your "skills" since it would require a negative alpha to maintain the equal sign: $\bar{g} = \bar{r}_m - \alpha$. For example, an expected 5% CAGR on your long-term portfolio would be: $\hat{\bar{g}} = 0.05 = 0.10 - 0.05$. That would be costing you money since you could have easily done better.

If you do not beat the market average, especially when it is so easy to do, you become the main reason why you are underperforming. It is not the market that is forcing you to underperform. It is your choice of trading methods. A result of the "skills" you should have brought to the game, and unfortunately did not. However, you will realize this only after some time has passed since the middle equation does depend on time. And time is one of your portfolio's limiting factors as well as your greatest asset.

Time Takes Time

No matter what you do trading, it will happen over those t years. And this will regulate everything else.

You should not wait 20 years to figure out that your trading strategy might be

detrimental to your portfolio or retirement fund. Nor should you think you can squeeze time and do in 20 years what would take 40 or more.

Yes, time is a real constraint. If you are 20 years old, you only have about 4 20-year periods left to live or less. You cannot waste any of them, especially in a compounding return game. Consider the following which will definitely hold:

$$F_0 \cdot (1 + \bar{g})^{20} < F_0 \cdot (1 + \bar{g})^{40} < F_0 \cdot (1 + \bar{g})^{60} \ll F_0 \cdot (1 + \bar{g})^{80}$$

whatever the value of \bar{g} , or of F_0 .

There is no cost for time, nonetheless, it is your most valuable asset.

With $\bar{g} = 0.20$, meaning you got some 10 alpha points ($\alpha = 0.10$) applied to the same starting capital F_0 , we would have the following based on the number of years the portfolio was held:

$$F_0 \cdot (1 + 0.20)^{20} = F_0 \cdot 38.34$$

$$F_0 \cdot (1 + 0.20)^{40} = F_0 \cdot 1,469.77$$

$$F_0 \cdot (1 + 0.20)^{60} = F_0 \cdot 56,347.51$$

$$F_0 \cdot (1 + 0.20)^{80} = F_0 \cdot 2,160,228.46$$

Whatever your initial capital F_0 , staying in the game for as long as possible does seem to take priority. Each period builds on prior periods. It does not add up fast, but it certainly adds up. Even after the first 20 years, you might be able to start taking some off the table as you please depending on if F_0 was large enough, something like one million⁺.

So, the question is: how much time do you really have: 20, 40, 60, or 80 years? One's portfolio does not need to retire at age 65, it could continue to prosper your entire life and be your legacy to your children or whatever other purpose you had in mind.

As an example, Mr. Buffett achieved the following: $F_0 \cdot (1 + 0.20)^{50} = F_0 \cdot 9,100$ over his first 50 years. So, it is doable and with not that many trades. Even if you had to do more trades than Mr. Buffett did over his career, it would still be quite an achievement.

Automated Strategies

A long-term automated trading strategy will need to evolve with time. Meaning that it should be taking bigger and bigger "positions" as the years go by. Without adapting to its time you should see your trading strategy hit the law of diminishing returns.

It is up to your trading strategy to compensate for this since the market is not designed to do it for you. You will simply have to enhance your portfolio equation.

As a side note, was reading today that a present 5-year-old by 2050 would have a 50% chance of reaching 100 years old. Therefore, planning for the very long term might not be that bad an idea.

A simple method would be to add more alpha: $F(t) = F_0 \cdot (1 + \bar{r}_m + \alpha_1 + \alpha_2 + \alpha_3)^t$. All of it would be compounding, and over the long term have quite an impact. For example: $\$1,000,000 \cdot [(1 + 0.22)^{40} - (1 + 0.20)^{40}] = \$1,377,256,191$. Just by adding 2% in alpha points. These alpha points are indeed valuable.

Say you are good at this game and manage to bring in an alpha of 20 ($\alpha = 0.20$). The same formula as above would give you:

$$F_0 \cdot (1 + 0.30)^{20} = F_0 \cdot 190.05 \quad \text{Using \$1 million, you get: \$190,049,638.}$$

$$F_0 \cdot (1 + 0.30)^{40} = F_0 \cdot 361,118.86 \quad \text{Using \$1 million, you get: \$36,118,864,808.}$$

In what follows, no one on this planet has yet gone that far:

$$F_0 \cdot (1 + 0.30)^{60} = F_0 \cdot 6,864,377.17 \quad \text{With \$1 million, you get: \$6,864,377,172,745.}$$

$$F_0 \cdot (1 + 0.30)^{80} = F_0 \cdot 1,304,572,395.05 \quad \text{Congratulation! You bought the planet some while back.}$$

Note that RenTec's Medallion Fund has achieved: $F_0 \cdot (1 + 0.39)^{30}$ which again demonstrates that some of it can be done.

Initial Conditions

All those formulas depended on the initial capital F_0 , and how long compounding will take place. How much you brought to the game is a major factor. If you come in with 10 times less, then you should move the result one decimal place to the left. You can put in 10 times more capital, then move one decimal to the right.

Not having the time, or the skills, you will have to rely on someone else to do that job. However, as stated in the previous article, 75% of professional money managers do not exceed long-term market averages, meaning that they generate less than \bar{r}_m .

In fact, stating that, on average, they generate negative alpha on their managed funds. So, what does it look like? Make the same calculations as above, but with $\bar{g} = 0.05$. You will get:

$F_0 \cdot (1 + 0.05)^{20} = F_0 \cdot 2.65$ With \$1 million, you would have: \$2,653,298.

$F_0 \cdot (1 + 0.05)^{40} = F_0 \cdot 7.04$ With \$1 million, you would have: \$7,039,989.

$F_0 \cdot (1 + 0.05)^{60} = F_0 \cdot 18.68$ With \$1 million, you would have: \$18,679,186.

$F_0 \cdot (1 + 0.05)^{80} = F_0 \cdot 49.56$ With \$1 million, you would have: \$49,561,441.

Again, should you start with 10 times less, simply move the decimal point to the left. But do ask yourself: why were you not able to do better than that?

Delayed Decision

The growth rate you get is almost a question of choice. The initial capital F_0 is definitely and totally under your control. You decide how much you will be able to put on the table. So is how much time you will put into it.

The time before you start your stock portfolio as well as the time after closing your portfolio might appear as having no value, but it has. You can gain something in the market only when you participate in it in some way or other.

You might be left with finding ways to improve on your long-term CAGR (\bar{g}). How much alpha will you be able to generate? Technically, it is making a "choice" on your expected outcome \hat{g} . Does it really matter? Well, yes.

Do you choose \hat{g} to be: 0.05, 0.10, 0.15, 0.20, 0.25, or 0.30⁺? The easiest to get is 0.10, the general long-term market average. You have to put in some alpha to move away from the expected norm, whether it be to underperform or overperform. In the first case with negative alpha and in the latter with positive alpha. Each positive alpha point you get will count over the long term. The alpha is compounding just as \bar{r}_m is. Not surprisingly, to generate negative alpha, someone has to work at it too.

Each year you delay building your portfolio, the more the lost opportunity cost rises. Say you manage to get $\bar{g} = 0.20$ or something close to it. Waiting for one year might appear as zero cost since you did not lose any money nor did you win any during that year. Nonetheless, waiting does have an opportunity cost.

The year you delayed propagates through the time series. You shifted the whole time series by one year. And therefore, what could have been year 40 is now year 41.

The delayed year's value: $\$1,000,000 \cdot [(1 + 0.20)^{41} - (1 + 0.20)^{40}] = \$293,954,314$.

That lost year would be costing you: \$293,954,314. Just because you procrastinated for 1 year which appeared at first as insignificant in the scheme of things. Saying you can start next year, or the year after that, might have some value after all.

A two-year delay would give: $\$1,000,000 \cdot [(1 + 0.20)^{42} - (1 + 0.20)^{40}] = \$646,699,490$. Regardless, it is still a choice you have to make.

It will be your portfolio after all, and you can do whatever you want.

Opportunity Costs

You are playing a compounding return game, and the last few years have tremendous weight on your final results.

Should you delay 20 years before you start your portfolio, here is an estimated opportunity cost should you also have had a 20% CAGR:

$$\$1,000,000 \cdot [(1 + \bar{g})^{60} - (1 + \bar{g})^{40}] = \$54,877,742,785$$

Since you only did 40 years, you would end up with \$1,469,771,568 instead of \$56,347,514,785. The outcome would still be more than reasonable, but you would now be in your 80s instead of your 60s. This is if you had started your portfolio at age 20.

The date you decide to start is your decision. No one can force you. However, if you were not ready to undertake this long journey, or did not have enough capital, or did not have a sufficiently strong trading strategy, or you were not interested in that kind of thing, you could always use those as excuses and I certainly would understand.

However, it does not change the math of the game. A major ingredient in your future success is time. How long will you be at it? How much initial capital can you get? And which inside or outside strategies will help you make it happen? Where does your alpha come from?

What Can You Do

That should be relatively simple, you have equations governing this thing and whatever you do, those equations will prevail.

Therefore, the emphasis should be on generating alpha and providing more time. The method does not matter much, you have a lot of them out there.

Your objective is not to get the best or optimal trading strategy, but simply to get a good one. You can always improve on it anyway.

The equations say you can trade all you want, and use any trading methods you want. Your first constraint will be time since everything will have to be done within that time limit. Your second constraint is your available capital. Both are under your control. The initial capital could come from anywhere.

There are limits as to how fast you can type and how many stocks you can follow at the same time. To be serious on making it big in trading stocks, you will have to automate the whole process. This way you will be able to follow 100 stocks or more if you wanted to, a machine would do the job.

To trade at the suggested levels (CAGRs at 20%+) you will need a software-driven trading system. Otherwise, you simply will not be able to keep up. There is simply too much work to be done by a single person, even worse if it has to be done by hand.

Nonetheless, you could adopt a more long-term investment approach instead of continuously trading. This could be done by increasing the holding period for most of the positions taken. In many cases, this might tend to reduce long-term CAGR potentials. That too has its own constraints.

One of which is the last part of the first equation: $F(t) = F_0 + N \cdot \bar{x}$. Any of the combinations presented have to follow that part of the equation too. And it implies that \bar{x} will need to be big, as a matter of fact, much bigger. No matter how large $F(t)$, the strategy will have to honor: $F(t) - F_0 = N \cdot \bar{x}$.

Take the 40-year scenario at a 20% CAGR which gave $F(T) = F_0 \cdot 1,469.77$, thereby turning \$1 million into \$1,469,770,000. What combination of N and \bar{x} would satisfy: $\$1,000,000 + N \cdot \bar{x} = \$1,469,770,000$?

We have: $N \cdot \bar{x} = \$1,468,770,000$. If you made, on average, \$200 per trade, you would need 7,343,850 trades over those 40 years. You should start to see the problem. That would amount to 706.14 trades per trading day! This is not impossible, Some financial organizations do even more than that already. However, consider what size of $F(t)$ you would need to do the same thing. It might exceed your limits.

What type of trading strategy could do the job? What should it trade, how should it trade, and based on what principles? The point being made is that whatever scenario you want to take, it will need to be explained in very simple terms. What was the average profit per trade and how many trades were required to get to your final result: $F(t) = F_0 + N \cdot \bar{x}$.

If your trading strategy cannot reach \hat{N} or $\hat{\bar{x}}$, you will have to be content with a lesser overall performance level. And that translates into a lesser CAGR.

The difference between a 10% and a 20% CAGR can be quite high, especially after many years. For instance, $\$1,000,000 \cdot [(1 + 0.20)^{40} - (1 + 0.10)^{40}] = \$1,424,512,312$. That is what is at stake.

You are still the one in charge of your portfolio. And it does matter that you pursue some higher growth rate \hat{g} where your trading skills will certainly come into play.

Trading Strategy Capacity

A trading strategy has a capacity of N trades over a trading interval of t . A 10-year or more simulation will give you a good approximation of this number. There is a limited number of trades from triggering signal crossovers over a long-term interval. And this will give you an estimate for \hat{N} . The same simulation will also give you an estimate for $\hat{\bar{x}}$.

If a simulation over some 10 years gave you $\hat{N} = 50,000$ with an average profit per trade of \$200, then your simulation generated: \$10,000,000. If you add another 10 years to your strategy, it should add some 50,000 trades or something in that vicinity. Your estimate for the added ten years would be another \$10,000,000 in profits for a total of \$20,000,000 over those 20 years.

Making modifications to your code, you should see the final outcome rise or fall depending on the trading procedures you would be trying to implement. This would have a tendency of changing the strategy's trade capacity, but only if you changed the trade triggering mechanics. Also, the bet size can easily be increased using some leverage, for example: $1.3 \cdot F(t) = 1.3 \cdot F_0 + \sum_1^N ((1.3 \cdot \mathbf{H}) \cdot \Delta \mathbf{P})$.

In [Use QQQ - Make the Money and Keep IT](#) was shown a strategy rebalancing on a weekly basis the 100 stocks part of QQQ. De facto, its capacity was 100 trades per week simply due to its rebalancing procedure. Week in and week out, it would generate about 100 trades.

Over the 12.24-year simulation, $\hat{N} = 636 \times 100 = 63,600$ trades. Test #3 generated 63,800 trades. The 200 extra trades were mostly due to changes in the composition of the QQQ ETF over the years. Test #2 was performed using \$1,000,000 as initial capital, it had a \$176.85 average profit per trade (\bar{x}) with an average CAGR of 20.76%. Note that to double your money every 3 years requires only a 26% CAGR.

You Can Do Better

The strategy mentioned above is freely available on [QuantConnect](#) courtesy of Vladimir, a talented member on QuantConnect. The strategy could be a good start where you could further enhance its trading procedures and add some downside protection before going forward.

The above-cited article also made the point that asymmetric rebalancing produced more than equal-weight rebalancing. In the strategy, weights were proportional to market capitalization, thereby putting more emphasis on the highest valued stocks in the group. There were 44 simulations performed on that trading strategy and some interesting observations were made.

It is always up to you to choose what your trading portfolio will be and will do. But

sometimes, a reasonable initial solution can be found ready-made. All you have to do is improve on it a little. In stock trading strategies, the best of them produce the most, and you should go for the best you can find or can generate on your own.

Here is a small chart to resume CAGR rates as covered in this article over the same time intervals:

Initial Capital (\$)		Portfolio Performance				
1,000,000		Compounded Annual Growth Rate				
Years	5.00%	10.00%	15.00%	20.00%	25.00%	30.00%
20	2,653,298	6,727,500	16,366,537	38,337,600	86,736,174	190,049,638
40	7,039,989	45,259,256	267,863,546	1,469,771,568	7,523,163,845	36,118,864,808
60	18,679,186	304,481,640	4,383,998,746	56,347,514,353	652,530,446,800	6,864,377,172,745
80	49,561,441	2,048,400,215	71,750,879,401	2,160,228,462,010	56,597,994,242,667	1,304,572,395,051,320
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IMHO, what you need is to make this big bet on America, that it will survive and prosper. The same bet as Mr. Buffett has made a long time ago and that the majority of Americans have also made. Live long and prosper...

One point barely mentioned was your present age. If you were 40 years old or older, you only have 3 20-year periods left or less. And it would be more than about time you started. One of the best gifts you can give to your child is to show him/her how to manage their own portfolios, so they can start at age 20 or sooner. What a legacy that would be in turn for their own children.

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