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The Math (and Discipline) of Compounding

Why Time Is the Investor's Greatest Asset

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ttvalueinvesting.com/education/compounding-math

1. Executive Summary

Compounding is the single most powerful force in long-term wealth creation, and yet it is also the most casually invoked and least seriously studied. Investors hear "compounding is the eighth wonder of the world" so often that the phrase has lost its substance. This paper restores the substance. Compounding is not a slogan; it is an arithmetic certainty that follows from a specific equation: $FV = PV \times (1 + r)^n$. Given a positive return r and enough time n, capital grows geometrically. That is not a forecast. That is mathematics.

What makes compounding fragile in practice is that the equation is unforgiving about its inputs. Investors do not control the market return r — that is a function of the world. But investors *do* control the variables that decide how much of r actually ends up in their pocket: how much they contribute, how long they leave it alone, how much they pay in fees, how efficiently they manage taxes, and — most importantly — how they behave in drawdowns. Each of these is a multiplier. Each of them, if mishandled, is a leak.

This paper focuses on the controllables. We will work through the formula, the role of time, the under-appreciated penalty of volatility (geometric vs. arithmetic returns), the compounding cost of fees, the drag of annual taxation, and the largest hidden cost of all — the behavioral tax. The thesis is straightforward: most investors fail to capture the compounding their portfolios *should* deliver, and the gap is almost always self-inflicted. The job of a fiduciary adviser is to close that gap.

2. The Formula

The math of compounding fits on one line:

$$FV = PV \times (1 + r)^n$$

Where:

- FV = future value (what your money is worth at the end)
- PV = present value (what you are starting with)
- r = the periodic rate of return (typically annual)
- n = the number of compounding periods (typically years)

In plain English: you start with some money, it grows by a percentage each year, and that growth itself grows the next year. The exponent n — time — is the mathematical reason small differences become enormous over decades. Doubling r from 4% to 8% does not double your future value over 30 years; it more than triples it, because the exponent is doing the heavy lifting.

When you are also adding new money each year — which most working investors are — the formula extends to:

$$FV = \Sigma_{t=0}^{n-1} C \times (1+r)^{n-t}$$

That looks intimidating, but the idea is simple: each annual contribution C has its own compounding clock. The dollar you put in this year compounds for n years. The dollar you put in next year compounds for $n-1$ years. Add them all up and you get the future value of a series of contributions.

A useful mental shortcut is the **Rule of 72**: the number of years it takes for money to double is approximately $72 / r$ (where r is in percentage points). At 6%, money doubles every 12 years. At 9%, every 8 years. At 3%, every 24 years. This single calculation is enough to grasp why the difference between a 5% net return and an 8% net return — over a 30-year horizon — is the difference between two doublings and four doublings. That is not a small gap. That is a different financial life.

Everything that follows in this paper is a meditation on the same equation. We are simply going to ask, in turn: what happens to FV when you change n? When you have a volatile r instead of a smooth one? When fees skim a percentage point off r? When taxes do? When fear causes you to step out of the market entirely?

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3. The Time Dimension — Why Starting Early Beats Saving More

The most counter-intuitive — and most expensive — lesson in personal finance is that *time matters more than amount*. To make this concrete, consider two hypothetical investors. The return assumption used here is purely illustrative.

- **Person A** invests *5,000 per year from age 25 to age 35, then stops contributing entirely. Total contributed:* **50,000**.
- **Person B** invests *5,000 per year from age 35 to age 65 — every year for 30 years. Total contributed:* **150,000**.
- Both portfolios are assumed to earn 7% annually (illustrative; not a forecast).

What does each look like at age 65?

Investor	Years Contributing	Total Contributed	Value at Age 65 (assumed 7%)
Person A (age 25–35, then stops)	10	$50,000	**~$602,000**
Person B (age 35–65)	30	$150,000	**~$510,000**

Person A contributed one-third of the cash and ended with more money. Read that again. The difference is not about discipline, income, or skill. It is about exponents. Person A's contributions had 30 to 40 years to compound. Person B's earliest contribution had 30 years; the last contribution had only one. The *average* dollar contributed by Person B compounded for roughly 15 years — half as long as Person A's average

dollar.

The point is not that Person B should not have invested. The point is that there is no substitute for time, and you cannot buy more of it later. Every year of compounding that gets skipped at age 25 is a year that has to be replaced with much larger contributions later — and the math says it usually cannot be replaced at all.

A note on the 7% assumption: this number is used in the example because it makes the arithmetic legible, not because it is a forecast. Real future returns are unknown. Past performance does not guarantee future results. The structural lesson — that time dominates contribution amount — does not depend on the specific return assumption. It would be true at 4%, true at 9%, and true at any non-trivial positive rate. What the assumption does is illustrate the magnitude of the gap.

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4. The Geometric vs. Arithmetic Distinction (Volatility Eats Compound Returns)

This section contains the most under-appreciated quantitative insight in all of personal investing. Most investors think in terms of *average* returns. They should be thinking in terms of *compounded* returns. These are not the same number, and the gap between them is volatility.

Consider a two-year hypothetical. An investment returns +50% in Year 1 and -50% in Year 2.

- **Arithmetic mean**: *(50\% + (-50\%)) / 2 = 0\%*. On average, the investment returned zero.
- **Geometric (actual) return**: A dollar grows to *1.50, then shrinks to* 0.75. You have lost 25% of your money over two years, or about **-13.4% per year compounded**.

You did not earn zero. You lost a quarter of your capital. The "average" lied to you.

This is not a curiosity. It is a structural feature of compounding, and there is a clean approximation for it:

$$Geometric\ Return \approx Arithmetic\ Return - \sigma^2/2$$

Where σ (sigma) is the standard deviation of returns — a measure of volatility. The more volatile a portfolio is, the larger the gap between its average return and its actual compounded return. This penalty is sometimes called **volatility drag** or **variance drain**.

The implication is profound. Two portfolios with the same arithmetic average return will compound to *different* terminal values if one is more volatile than the other. The smoother portfolio wins. Consider the following stylized two-asset comparison over four years (illustrative; assumed returns):

Year	Portfolio X (Steady)	Portfolio Y (Volatile)
1	+7%	+25%
2	+7%	-10%
3	+7%	+25%
4	+7%	-10%
Arithmetic Average	**7.0%**	**7.5%**
Geometric (Actual) Return	**7.0%**	**~6.1%**
Growth of $100	**~$131**	**~$127**

Portfolio Y has a *higher* average return and *less* terminal wealth. Volatility ate the difference and then some.

The investment-management implication: drawdown management is not a side concern. It is central to compounding. A portfolio that goes down 50% has to gain 100% just to break even — not because of any psychological quirk, but because that is what the arithmetic requires. Avoiding deep losses is mathematically more valuable than chasing extra upside, especially in the back half of an investing lifetime when there is less time to recover. This is one of the reasons we focus on the *quality* of underlying businesses and the *durability* of cash flows rather than the most exciting price-momentum names in any given quarter. Steady compounding is not a consolation prize for the conservative. It is, in many cases, the highest terminal wealth available.

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5. The Cost of Cost — How Fees Compound Against You

If compounding works on returns, it also works on the absence of returns. Every basis point you pay in fees is a basis point that does not compound for you. Over decades, this is brutal.

Consider $100,000 invested for 30 years at an assumed 7% gross annual return:

Annual Fee	Net Return	Value After 30 Years	Lost to Fees
0.00% (no fee)	7.00%	**~$761,000**	$0
0.50%	6.50%	~$661,000	~$100,000
1.00%	6.00%	**~$574,000**	**~$187,000**
1.50%	5.50%	~$498,000	~$263,000
2.00%	5.00%	**~$432,000**	**~$329,000**

A 1% annual fee — which sounds modest — turns into roughly a *187,000 haircut on a* 100,000 starting balance over 30 years. A 2% fee, common in many wrap programs, costs $329,000 — more than three times the original principal. The reason is not that the fee compounds on your money once. It compounds *every year, against you, for the entire holding period*. It is a parallel compounding machine running in the opposite direction.

This is one of the strongest arguments for being deeply intentional about cost. When an active strategy is genuinely earning its fee — through risk-adjusted excess return, tax efficiency, behavioral coaching, or a combination — it can be well worth what it costs. When it is not, the math is merciless. Low-cost index funds exist precisely because, for the portion of a portfolio that is not earning differentiated value through active selection, the expense ratio should be as close to zero as possible. The point is not that all active management is bad — at TTCM, we believe disciplined value investing in selected businesses can deliver value over a full cycle — but that *every* dollar of fee, ours included, has to justify itself against this compounding math. We hold ourselves to the same standard we ask you to apply to every product in your portfolio.

6. The Cost of Tax Drag

There is a second compounding machine that runs against most investors: annual taxation. When dividends, interest, or realized gains are taxed each year, the after-tax amount that is left to compound is smaller than the gross amount that *would* have compounded in a tax-deferred account.

Consider an illustrative scenario. $100,000 invested at an assumed 7% annual return for 30 years, with a 24% marginal tax rate applied to all annual returns:

Account Type	Effective After-Tax Annual Return	Value After 30 Years
Tax-deferred (401(k), IRA)	7.00% (taxed only at withdrawal)	**~$761,000 (pre-tax)**
Fully taxable, taxed annually	7.00% × (1 – 0.24) = 5.32%	**~$469,000**

The tax-deferred account ends with roughly **62% more pre-tax wealth** than the annually taxed account. Even after a final withdrawal tax on the deferred account, the deferred structure typically wins by a wide margin — often by more than 30% in real terms — because the tax that was *not* paid each year continued to compound on your behalf. This is sometimes called the "interest-free loan from the IRS." You will eventually pay tax on growth in a traditional IRA or 401(k), but in the meantime the dollars that would have gone to taxes are working for you, generating their own returns, which then generate further returns.

The practical implications, which we explore in greater depth in our companion paper *Roth vs. Traditional IRA*, are:

- Maximize tax-advantaged accounts (401(k), Traditional IRA, Roth IRA, HSA) before adding to taxable accounts.
- Locate tax-inefficient assets (taxable bonds, REITs, high-turnover strategies) inside tax-deferred wrappers when possible.
- Locate tax-efficient assets (broad equity index funds, long-term equity holdings, municipal bonds) in taxable accounts.
- Harvest losses where appropriate, and minimize unnecessary realization of short-term gains.

Tax drag is one of the few compounding leaks where small structural decisions made today produce six-figure differences over a working lifetime. Tax treatment varies by account type, state, and individual situation; a qualified tax professional should review specifics.

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7. The Behavioral Tax — The Largest Hidden Cost

Fees and taxes are visible. The largest leak in most investors' portfolios is invisible, because it shows up only in the gap between what their funds returned and what *they* returned.

Industry studies of investor behavior — looking at actual dollar-weighted returns of mutual fund investors versus the published time-weighted returns of the funds themselves — have consistently shown that the average investor underperforms the very funds they own, often by several percentage points per year. This is not because of fees. It is because investors put money in after good years and pull it out after bad years. They buy high and sell low, repeatedly, in aggregate, across decades.

Why? Because loss aversion is not a personality flaw. It is wired into the human brain. Behavioral research has shown that the psychological pain of losing *10,000 is roughly twice as intense as the pleasure of gaining* 10,000. That asymmetry is fine in the savanna; it is catastrophic on Wall Street. It strikes hardest exactly when it is most expensive — at market bottoms, when the news is darkest, when every instinct says *get out*.

Consider what selling at a 2008-style or 2020-style bottom does to compounding. If an investor moves to cash near the bottom of a drawdown and then waits to "feel safe" before re-entering — typically after a substantial recovery — they have permanently locked in a loss and missed the snap-back that historically delivers some of the best return periods in any given cycle. Decades of compounding can be compromised by a single panic-driven decision in a single quarter. The math from Section 4 applies here too: the deeper the realized loss, the larger the recovery needed just to break even.

This is the behavioral tax. It does not appear on any fee schedule or tax form. It compounds silently, and in our experience, it is the single largest reason real-world portfolio outcomes diverge from textbook compounding outcomes.

This is also the place where a fiduciary adviser earns their keep. The market does not care about your panic. But a competent fiduciary in your corner — one who has been through 2000, 2008, 2020, and other periods

of acute stress — can be the structural reason you do not act on it. Helping clients *not sell* at the bottom is, over a lifetime, often the most valuable thing we do. It is also the least visible. Nothing happens. The portfolio stays invested. The compounding continues. That is the deliverable.

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8. The Compounding Killers (a Cheat-Sheet)

The variables that reliably interrupt compounding, in rough order of how much damage they tend to do over decades:

- **Selling during drawdowns.** The behavioral tax. By a wide margin, the largest leak.
- **Market timing.** Trying to step out before a correction and back in before a recovery. The math requires being right twice in a row, repeatedly. Almost no one is.
- **High fees and expense ratios.** A second compounding machine running against you. Most damaging when paired with mediocre performance.
- **Frequent trading and short-term capital gains.** Realized gains are taxed; short-term gains are taxed at higher ordinary-income rates. Turnover is expensive.
- **Concentrated bets that don't pay off.** Single-stock concentration that goes wrong does not just reduce compounding — it can erase the principal that was supposed to compound in the first place.
- **Inadequate tax planning.** Wrong asset in wrong wrapper. Failure to use tax-advantaged accounts. Failure to harvest losses where appropriate.
- **Lifestyle inflation absorbing income.** The dollar that gets spent on a slightly nicer car is the dollar that does not compound for 30 years. The opportunity cost of consumption is invisible at the moment of purchase.
- **Excessive cash holdings beyond a real emergency reserve.** Cash earns less than inflation over long horizons. "Safe" in nominal terms is "shrinking" in real terms.

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9. The Compounding Multipliers (the Other Side)

The same list, inverted, becomes the operating manual for letting compounding work:

- **Long time horizons.** The non-negotiable input. Start as early as possible. Stay invested as long as possible.
- **Consistent contribution rates.** Automated, dollar-cost-averaged contributions to retirement and taxable accounts. Boring, mechanical, and very effective.
- **Tax-advantaged accounts.** Max the 401(k), the IRA, the HSA, the Roth where appropriate. These wrappers are compounding accelerators.

- **Low-cost vehicles.** Index funds where active management is not earning its fee. Honest expense-ratio scrutiny on every position.
- **Genuine diversification.** Diversification is not "ten technology stocks." It is exposure across asset classes, geographies, sectors, and factors that do not all move together.
- **Quality bias.** Owning durable businesses with strong balance sheets reduces the depth of drawdowns and therefore the damage of volatility drag.
- **A behavioral framework for staying invested through volatility.** This is a fiduciary's job to provide. It is built before the storm, not during it.

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10. A Word on Inflation

All the math above is in nominal terms. In real life, inflation is a third compounding machine, and like fees and taxes, it runs against you.

The simple correction:

$$\textit{Real Return} \approx \textit{Nominal Return} - \textit{Inflation Rate}$$

A 7% nominal return at 3% inflation is roughly a 3.9% real return. (The exact relationship is multiplicative — $(1.07 / 1.03) - 1 \approx 3.88\%$ — but the subtraction approximation is close enough for planning.)

Two consequences follow:

One, do retirement planning in real terms, not nominal. A retirement target of "$2 million" is meaningless without specifying the year's purchasing power. Two million in 1995 dollars is not two million in 2025 dollars. Plan in inflation-adjusted dollars.

Two, cash held aside for "safety" is not as safe as it looks. A nominal balance that does not change is, in real terms, a balance that shrinks every year by the inflation rate. Holding cash beyond a true emergency reserve is a slow, silent compounding loss. Inflation does not fluctuate visibly day to day, which makes it easy to ignore. Over 20 years, the cumulative loss of purchasing power on excessive cash holdings is often greater than any market drawdown the investor was trying to avoid.

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11. What This Means for How TTCM Manages Money

This paper has been a meditation on a single equation and the variables that surround it. The conclusions translate directly into how we run portfolios.

We focus on **quality businesses** because durable cash flows produce shallower drawdowns, and shallower drawdowns reduce volatility drag on the geometric return.

We focus on **low-cost structures** — both at the underlying-fund level and at our own advisory level — because every basis point of cost is a basis point that does not compound for you. We hold our own fee to the same scrutiny we ask you to apply to every fund in your portfolio.

We focus on **tax efficiency** — asset location, holding periods, loss harvesting where appropriate, coordination with retirement-account decisions — because the difference between an after-tax 5% and an after-tax 6% over 30 years is a different financial life.

We focus on **behavioral discipline**, both in our process and in our client relationships, because the data is unambiguous: the largest leak in most portfolios is the investor's own loss aversion, expressing itself at exactly the worst moment.

We accept that we will not catch every speculative top. We will hold through periods of underperformance relative to whatever happens to be working in the headlines that quarter. What we will do is be there in the drawdowns, when most investors are tempted to give up, and we will put the math in front of you that explains why holding through is, more often than not, the rational decision.

The combination of patient capital, tax-aware structuring, low cost, quality bias, and behavioral coaching is not glamorous. It does not generate exciting cocktail-party stories. It does, over decades, compound. That is the entire point. The biggest enemy of compounding is not the market. It is interrupted compounding — and almost every interruption is self-inflicted.

12. Closing

> *If you have been investing for a decade or more and you are not sure whether your current account structure, fund holdings, fee load, and tax strategy are letting compounding work in your favor — that is the conversation we have most often.* ***Schedule a complimentary 30-minute review with Tim Travis.*** *No fee, no obligation, no pressure. We will walk through your specific situation, point out where compounding is working for you and where it is leaking, and you can decide what to do with that information.*

Disclaimer

This is general educational content and is not personalized investment, tax, or legal advice. Examples in this paper use illustrative return assumptions (commonly 7%) for arithmetic clarity. Actual market returns vary widely, including the possibility of negative returns and permanent loss of capital. ***Past performance does not guarantee future results.*** *Tax treatment varies by account type, state, and individual situation; consult a qualified tax professional. T&T Capital Management is an SEC-registered investment adviser. Registration with the SEC does not imply a certain level of skill or training.*