

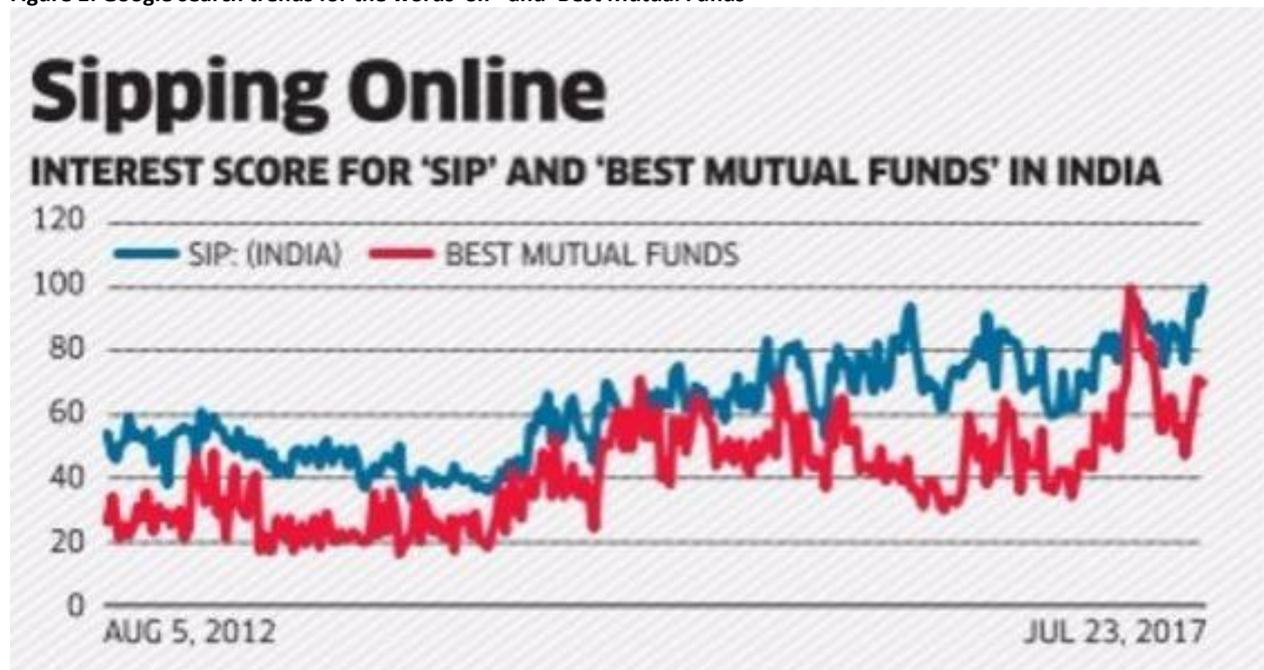
**Background**

The Fallacies of Our Mind is a series dedicated to our behavioural pitfalls. This series aims to explain that many of our ‘instincts’ are detrimental to our investment results. As we have said in the past, while we cannot re-wire our brains, it is important that we understand its shortcomings and design an investment process that helps us overcome these emotional hurdles. Mental models, as referred to by Charlie Munger, should be looked upon as the various tools in the toolkit of a technician. Each tool helps solve a specific problem and no one tool can solve all the problems. An astute investor, therefore, should hold a repertoire of these mental tools in his/her toolkit at all points in time. You can read our previous newsletters on this subject [here](#) and [here](#).

**Lessons from boiling a frog**

The growth and scale of the SIP (Systematic Investment Plan) books of domestic mutual funds have garnered a lot of attention recently. From personal finance columns in newspapers, investor education by mutual funds (recent SIP Day by a domestic mutual fund, for instance) to Google search trends about investments, everyone seems to have caught on to the SIP buzz. According to Google data compiled by ETIG (Economic Times Intelligence Group, the research arm of The Economic Times), the search for SIP has touched a score of 100 - indicating peak popularity of a term in a defined time frame. While highly popular, SIP is not a recent phenomenon. It is a trend that has been developing gradually, initially at a pace that went unnoticed, but more recently attaining a size that is difficult to ignore (think compound effect!).

Figure 1: Google search trends for the words ‘SIP’ and ‘Best Mutual Funds’



Source: ETIG, Google

Before discussing this trend further, let us first talk about a mental model called ‘The Boiling Frog Syndrome’. In his famous speech titled ‘The Psychology of Human Misjudgment’, Charlie Munger quotes a story he heard from his friend: *“If you throw a frog into very hot water, the frog will jump out, but if you put the frog in room temperature water and just slowly heat the water up, the frog will die there.”*

While the story may not be factually correct, the underlying principle is worthy of attention. The basic premise of this story is that small incremental changes tend to go unnoticed. Metaphorically, the frog

represents businesses that remain oblivious to small changes in marketplaces, until the cumulative change is so large that they end up going bankrupt (think camera film makers and the advent of digital cameras, fixed line telephony and mobile phones). This mental model is not a metaphor for businesses specifically, but for human cognition in general.

Remember how excited you were when the stock you held was up 5% in a single day, but you didn't notice how your other holding rose 1% a day for five days? That's the Boiling Frog Syndrome at work. Our brains are wired such that we tend to pay more attention to large changes rather than small increments. It's the same when we look at data – unless the variable has moved up or down sharply, or it has suddenly changed the course of its direction, we do not pay much attention to data (how many times have you discussed India's Current Account Deficit (CAD) recently, as compared to say, 4 years back?)

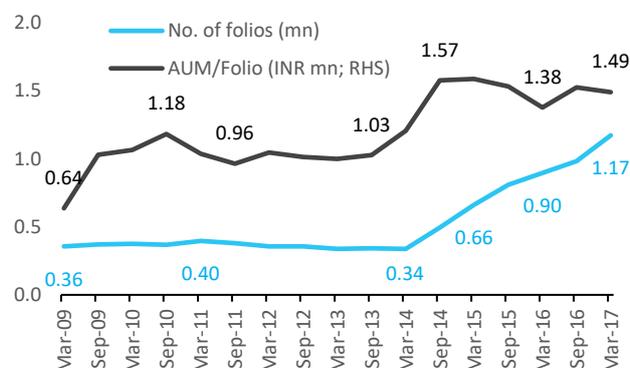
**Figure 2: India Quarterly CAD (USD Mn)**



Source: tradingeconomics.com

The attention received by SIP investments is also an example of the Boiling Frog Syndrome. While a lot of attention is being paid to the growing participation of the retail investor via SIP in the last 1-2 years, this phenomenon did not develop overnight. Rather, like most trends, this one has been developing gradually over the years. For instance, the Google search trends depicted in Figure 1 show that for more than half of the period between 2012 and 2017, the search score for SIP was above 60 – significant, even though not a peak. Similarly, mutual fund folio data reflects a sharp uptick in individual investor interest starting March 2014 (HNI folios nearly trebled between Mar'14 – Mar'16, while retail folios grew by a quarter during that period, as shown below).

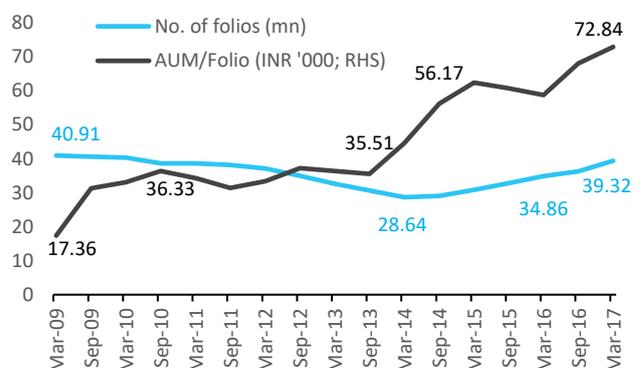
**Figure 3: Equity Oriented Mutual Fund Investments - HNI\***



\* Defined as individuals investing Rs 5 lakhs and above

Source: AMFI, Tamohara.

**Figure 4: Equity Oriented Mutual Fund Investments - Retail**



Source: Tamohara

## The problem with linear thinking

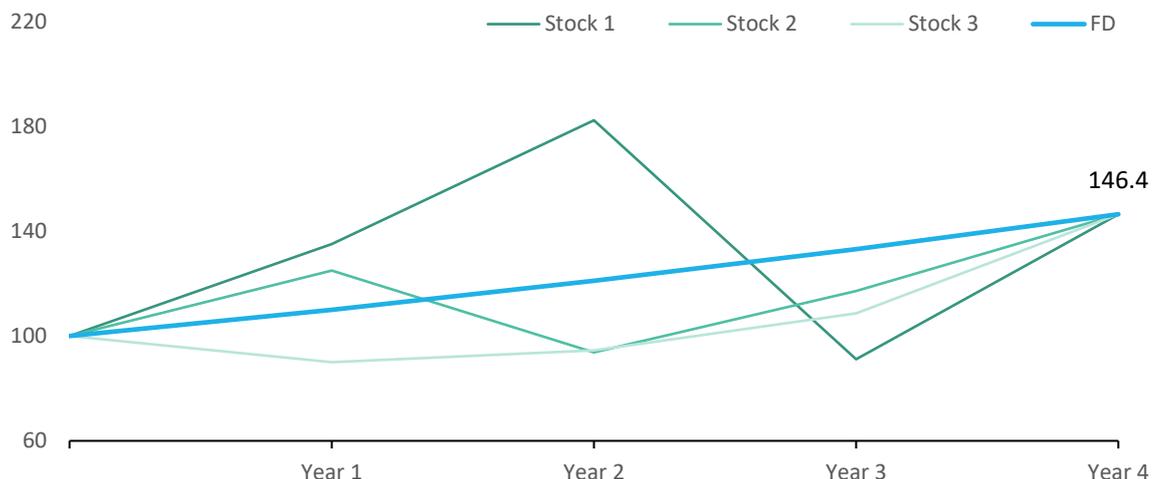
This bias towards large changes as against small increments turns into a much larger problem with time and the relationship between the variables. Let's run through a couple of examples to understand this.

- Rank the following investment options in order of your preference (best to worst). Assume that all the returns are post tax, post expense. Please try and answer without using any external help like a calculator.

	STOCK 1	STOCK 2	STOCK 3	FD
Year 1	35%	25%	-10%	10%
Year 2	35%	-25%	5%	10%
Year 3	-50%	25%	15%	10%
Year 4	61%	25%	35%	10%
<b>Sum Total of Returns</b>	<b>81%</b>	<b>50%</b>	<b>45%</b>	<b>40%</b>

If you ranked these investments in the above order, then you approached the problem linearly. In fact, any ranking of these investments other than all being equal would be an incorrect answer. The following chart depicts the year-wise outcome of all these investments:

Figure 5: Value of INR 100 invested in each of the investment options for four years



Source: Tamohara

Notice how the end result of each investment outcome is the same? Not only is the brain biased towards large increments (which you may have noticed while wanting to choose one of the stock options over FD), it is also not able to comprehend the impact of compounding. This is because compounding is not a linear function like addition and subtraction, but a non-linear function. Let's look at another example to understand this in more detail.

- The following is an extract (with minor edits) from a wonderful Harvard Business Review [article](#) on non-linear thinking.

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Test yourself with this word problem: Imagine you're responsible for your company's car fleet. You manage two models, an SUV that gets 10 miles to the gallon and a sedan that gets 20. The fleet has equal numbers of each, and all the cars travel 10,000 miles a year. You have enough capital to replace one model with more-fuel-efficient vehicles to lower operational costs and help meet sustainability goals.

Which upgrade is better?

- Replacing the 10 MPG vehicles with 20 MPG vehicles
- Replacing the 20 MPG vehicles with 50 MPG vehicles

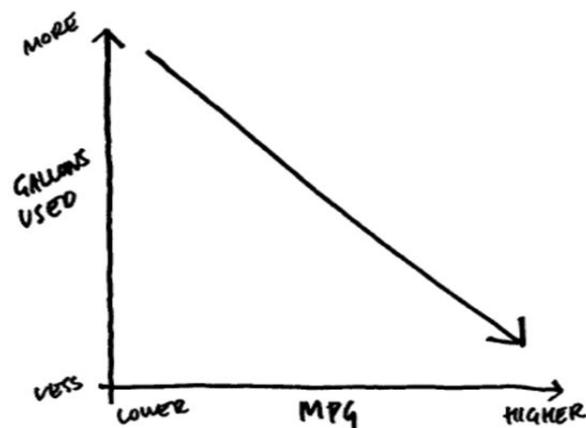
Intuitively, option B seems more impressive - an increase of 30 MPG is a lot larger than a 10 MPG one. And the percentage increase is greater too. But B is not the better deal. In fact, it's not even close. Let's compare.

	GALLONS USED PER 10,000 MILES	CURRENT	AFTER UPGRADE	SAVINGS
A.	1,000	1,000 (@10 MPG)	500 (@20 MPG)	500
B.	500	500 (@20 MPG)	200 (@50 MPG)	300

Is this surprising? For many of us, it is. That's because in our minds, the relationship between MPG and fuel consumption is simpler than it really is. We tend to think it's linear, which makes it look like Figure 6.

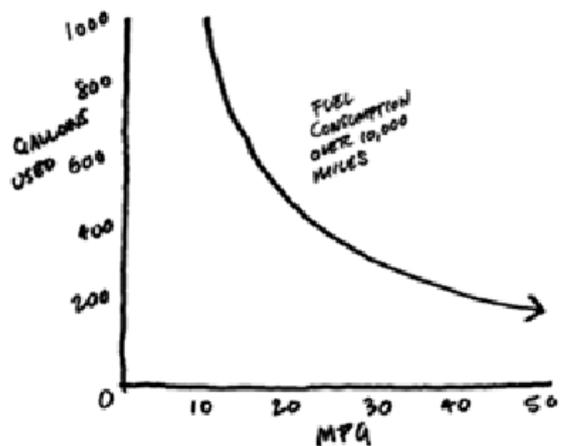
But that graph is incorrect. Gas consumption is not a linear function of MPG. When you do the math, the relationship actually looks like Figure 7.

Figure 6: Representation of a linear model



Source: Harvard Business Review

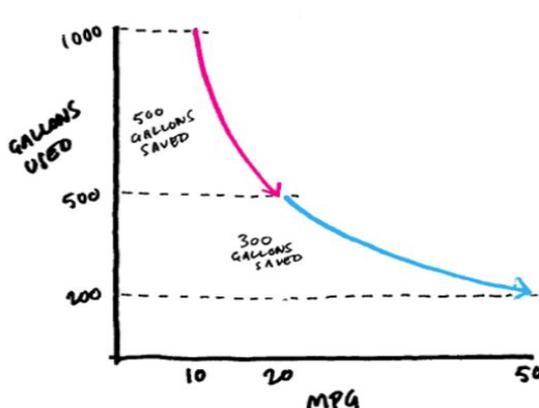
Figure 7: Representation of a non-linear model



Source: Harvard Business Review

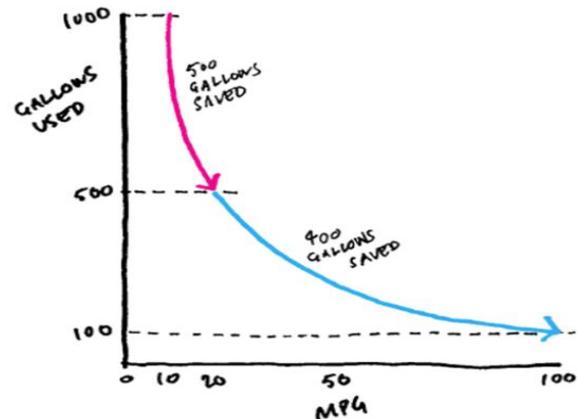
And when you dissect the curve to show each upgrade scenario, it becomes clear how much more effective it is to replace the 10 MPG cars (Figure 8). Shockingly, upgrading fuel efficiency from 20 to 100 MPG still wouldn't save as much gas as upgrading from 10 to 20 MPG (Figure 9).

Figure 8: Upgrade Scenario 1



Source: Harvard Business Review

Figure 9: Upgrade Scenario 2



Source: Harvard Business Review

But choosing the lower-mileage upgrade remains counterintuitive, even in the face of the visual evidence. It just doesn't feel right.

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If you're still having trouble grasping this, it's not your fault. Decades of research in cognitive psychology shows that the human mind struggles to understand non-linear relationships. Our brain wants to make simple straight lines. In many situations, that kind of thinking serves us well: If you can store 50 books on a shelf, you can store 100 books if you add another shelf, and 150 books if you add yet another. Similarly, if the price of coffee is \$2, you can buy five coffees with \$10, 10 coffees with \$20, and 15 coffees with \$30.

But in business, there are many highly non-linear relationships, and we need to recognise when they're in play. This is true for generalists and specialists alike, because even experts who are aware of non-linearity in their fields can fail to take it into account and default instead to relying on their gut. But when people do that, they often end up making poor decisions.

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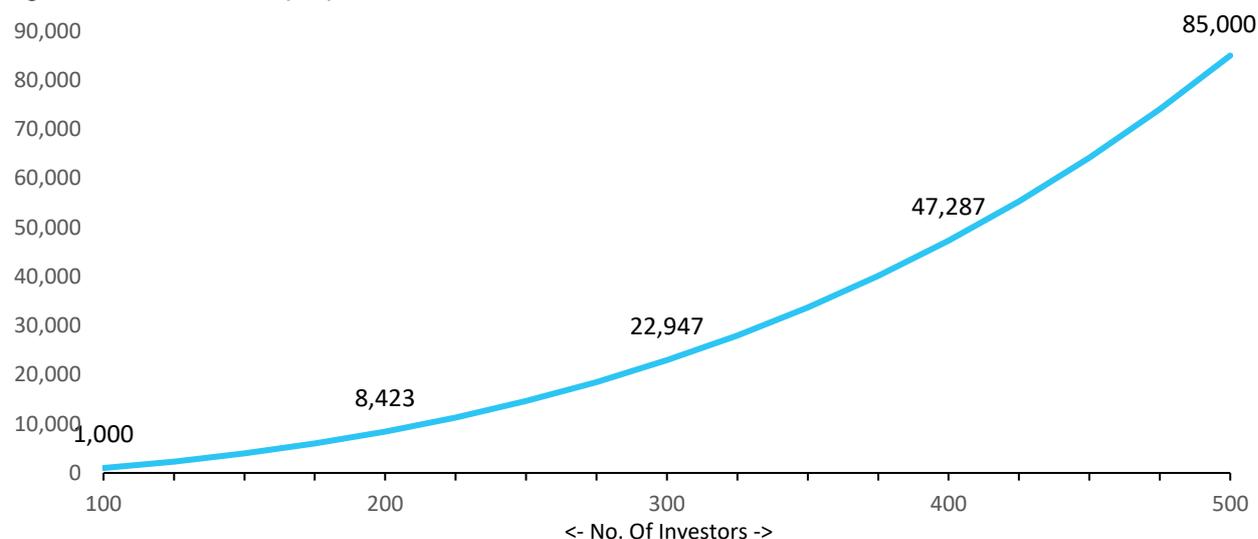
A linear function ( $2+2+2 = 3*2 = 6$ ) is, thus, a straight-line graph, whereas a non-linear function ( $2*2*2 = 2^3 = 8$ ) is a curve. In other words, a linear function is one where the difference between any two successive values is constant (the difference between 2 & 4 is 2, 6 & 4 is 2, and so on). On the other hand, in a non-linear function, the difference between successive values is not a constant ( $2^1 = 2$ ,  $2^2 = 4$ ,  $2^3 = 8$ ; the difference between 4 and 2 is 2, but the difference between 8 and 4 is 4, and so on). This [video](#) explains very simplistically the difference between linear and non-linear functions. The bottom-line of the above is that while the brain can easily decode a straight line, it has a very tough time comprehending a curve.

### Conclusion

Having understood these two shortcomings of our brain – the inability to notice small incremental changes, and the inability to comprehend non-linear relationships – it is important that we do not ignore small changes in trends any more. This is not to say that every small deviation may lead to a meaningful new trend. However, it is important to realise that small incremental changes can potentially lead to a large deviation over time, especially in the case of non-linear relations. Let's look back at our SIP example. Assume that 100 investors start a SIP of an amount of INR 10 every year. Each year, 25 more investors decide to start the SIP, and each year, the amount invested by every investor goes up by 5% (assuming that an increase in income will lead to higher savings and investments). The following exhibit charts the annual SIP book:

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**Figure 10: Annual SIP Book (INR)**



Source: Tamohara

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Notice how, as the number of investors increase from 100 to 200, the SIP book increases by an amount of over INR 7400. Similarly, as the number of investors increase from 200 to 300, the SIP book increases by an amount of over INR 14,500 and then by over INR 24,000 and so on. Notice how a small change in variables (number of investors and amount invested by each investor) leads to a large change in the outcome (SIP AUM).

These are the lessons from the Boiling Frog Syndrome and Non-Linear Thinking for you. We hope that the awareness of these tools helps you in making better decisions, especially in identifying trends early.

A word of caution before we end: In using these mental models, do not fall prey to the 'Man with the Hammer' syndrome (*To a man with a hammer, everything looks like a nail. Think of a doctor who has only learnt to perform surgery. S/he will therefore use surgery to treat every health problem, even if it could be cured by a less invasive procedure*). Remember that there are numerous other biases that you need to be careful of when dealing with data, trends and forecasts. We'll cover some of these topics in the future under this series. Before that though, we'll present some more interpretations from our SIP example next month.

Until then,  
On behalf of Team Tamohara,  
**Tejas Gutka**

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