Why Accumulation Bias Matters for Financial Decision Making

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Evolution has never tolerated much inaccuracy in perceptions of the physical environment. Those who misjudged the distance to the next branch were generally the gone-too-soon siblings of our ancestors. Similar abrupt exits from the gene pool were made by those who confused the colours of edible and poisonous berries, and so on. Modern human vision is not accurate by accident.

Today, inaccurate judgment can still harm welfare, but the domains in which we are likely to exhibit costly misperceptions have changed. One such area is financial decision making. The need to allocate monetary resources over (often long) periods of time is a very recent problem in human history, so no reliable intuition has developed to solve problems of this nature with ease and precision.

Accumulation, the process by which quantities build up over time, is at the centre of most financial problems: whether it is saving or borrowing decisions, or consumption decisions about whether to pay for a product upfront or in a series of instalments. On this latter point, recurring payments for goods and services is becoming increasingly common. For instance, mobile phone contracts and car finance arrangements take this form. And many digital services (e.g. Netflix, Spotify) require monthly payment for an indefinite time period.

Traditional models of consumer choice simply assume that people calculate total costs of this kind without error. But evidence from neuroscience and psychology suggests the ‘number sense’ that is used to carry out accumulation calculations is prone to error in a systematic way.[1] A tendency to underestimate accumulation has been documented in numerous lab and field experiments.[2] One explanation is that the internal 'mental number line' is not linear, with the same amount of space being devoted to each number, but log-linear, meaning more space is given to small numbers while larger ones are clumped together.[3] An evolutionary argument can also be made for why the observed accumulation bias is negative: For a hunter-gatherer, it would be less detrimental to underestimate the total amount of food in an area than overestimate it, as the latter might lead to deadly complacency about one's resource pool.

The economic literature that shows reframing prices from annual to daily, the so-called pennies-a-day technique,[4] often increases willingness to purchase goods, implying underestimation of the accumulated total cost. Similarly, a large volume of research suggests that splitting product prices into components can systematically lead to underestimations of total prices.[5]

Understanding the accuracy of accumulation intuitions also matters questions for economic theory: do choices reflect true preferences, or might they be mistakes? Whenever consumers choose between options that vary in the degree to which costs are disaggregated over time, there is potential for inaccurate perceptions of accumulation to be misconstrued as time preferences. If individuals underestimate accumulation, their choices may make them *appear* impatient. Consider choosing a two-year phone contract. One option bundles a 'free' phone with services and costs €50 per month (total cost €1200). Or they could buy the phone separately for €500 and purchase a €20 per month services contract (total cost €980). If the first option is chosen, can we pin down what is driving this choice? Time preferences – 'I don't mind paying €220 *more* overall if I pay less *now'* – is one explanation.[6] Alternatively, the accumulated cost of the 'free phone contract' could be underestimated. Policy implications differ greatly depending on the cause.

But why would people rely on shaky intuition that is prone to error to make financial decisions - such as which phone contract to buy - when they could engage in slow and deliberative problem-solving processes with the aid of a calculator instead? Because taking the slow, analytical approach requires all of the following: individuals being aware of their own risk of error, knowing that a calculator might help them, knowing how to use the calculator to solve the problem, and having ample time to do so before the decision must be made. None of these factors is trivial. As a result, financial decisions are often taken based on intuitive judgments rather than slow and analytical ones. That is why it is important to understand such intuitions, especially when financial wellbeing is such a vital factor to overall health and happiness. Decision tools that dovetail with these intuitions, thus lowering the 'how to use' barrier, are likely to be more useful than totally abstract tools.

We explored the potential of intuitive decision aids to improve the accuracy of perceptions of money growth in the context of retirement saving. In recent decades, responsibility for retirement planning has shifted from employers and institutions to individuals.[7] One documented reason individuals undersave is that they tend to underestimate the power of compound interest, called exponential growth bias (EGB) in the literature.[8] But when the saving plan involves making regular payments over time, savers also need to estimate accumulation. We hypothesised that this might be a factor independent to EGB that leads to the 'cost of delay' of saving for retirement being underestimated.

We conducted controlled laboratory experiments on representative samples of the population (n = 280). The experiment designs allowed separate measurement of EGB and accumulation bias.[9] For one group of participants, we framed the costs of delay in monetary terms -"How much more will I need to save if I start later?" For the other half, we framed the cost in terms of time. For this half of the sample, the question was "How long can I wait to start saving if I commit to saving more when I do start?" In the first judgment task experiment (n =100), participants were shown two saving scenarios (e.g. Peter saves €200 per month from age 30 at 3% interest). However, in one scenario either the amount saved or the age at which the saving started was missing. The participant's task was to 'fill in the blank' so that the total amount saved by retirement was the same in both scenarios. In both frames, we recorded substantial EGB and considerable degrees of accumulation bias.

In the second experiment (n=180), the task was simpler. Participants looked at two individuals' scenarios, one of whom had started saving at a younger age and one of whom started later but saved more. They clicked on who they thought would have more at retirement. Before completing this task, two groups got to use a money growth calculator that was designed to explain the cost of delay in time or money (a control group used no calculator). Using the calculator designed to make explicit the monetary cost of delaying saving significantly and substantially reduced underestimation. But the results also suggested that the beneficial effect of the calculator was specific to people with higher educational attainment. This experiment showed that in addition to displaying EGB, individuals failed to appreciate the degree to which small regular contributions accumulate over long periods of time.

The process of accumulation is embedded in nearly all financial decisions. As my PhD progresses, the aim is to further analyse the psychological mechanism underlying accumulation bias in a laboratory setting, and then move towards applied settings in the field. The aspiration is that findings will help policy makers design an environment where individuals can swing successfully between financial branches.

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