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Mental Time Travel and Retirement Savings †

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Abstract: We portray the valuation of retirement savings in terms of a mental time travel journey in which a proposed contribution to a pension plan is projected forward to the plan member's retirement date and this projected value is then discounted back to today, thereby giving a present or personal value. We set this within a broader framework of pension planning, which seeks to smooth consumption over the lifecycle. We explain how two psychological biases—exponential growth bias and present bias—can lead to a difference between the initial value of a pension contribution and its present value, such a difference reflecting an asymmetry between projection and discounting, and how such a difference might lead to inadequate retirement savings and hence to a lower than desired standard of living in retirement. We consider how the two biases might be mitigated.

Keywords: retirement savings; lifecycle model; financial investment valuation; mental time travel; time perception; projecting; exponential growth bias; discounting; present bias; symmetric; asymmetric; valuation

JEL Classification: G4; G51

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1. Introduction

One of the key issues in household finance is the funding of the retirement of the household's members. In most countries in the developed world, the State provides a pension, but in many of these countries—the UK is an example—this pension does not typically provide an adequate income in retirement, and people are encouraged to make additional private provision by saving in a pension plan. However, many households find it hard to save enough for an adequate pension in retirement. We argue in this paper that this is, in large part, because individuals find it difficult to value rationally financial investments. As a result, they typically underestimate future pension values and, hence, are reluctant to save now unless either compelled or nudged into doing so.

In our paper "Mental time travel and the valuation of financial investments" (Blake and Pickles 2021, denoted MTT for short), we conjecture that the valuation of financial investments involves mental time travel—forwards into the future and back to the present. That paper explores some of the different paths such travel might take. In a series of "thought investments": an invested $1 is projected forward in time, and the projected value is then discounted back—so giving us the investment's present or personal value.

In this paper, we employ our MTT Framework to illustrate the relative effects on the personal valuation of pension contributions of two psychological biases—"exponential growth (EG) bias" and "present bias"—which a body of independent research identifies as significant predictors of retirement savings. EG bias is the failure to understand compounding; while present bias is the tendency to value the present over the future (Goda et al. 2019).

The outline of this paper is as follows. In Section 2, we discuss pension planning in the context of the lifecycle model. In Section 3, we portray financial investment valuation as mental time travel. In Section 4, we conduct a mental time travel retirement savings' thought investment which reflects the asymmetric influence of EG bias and present bias on the discounted projected future value of a potential pension contribution, rendering it unattractive as an investment. In Section 5, we look at empirical evidence for the presence of these two biases, while Section 6 suggests ways in which they might be mitigated, and Section 7 concludes.

2. The Lifecycle Model and Pension Adequacy in the Real World

2.1. The Lifecycle Model

The standard model used by economists to explain economic behavior over a long-term investment horizon is the lifecycle model (LCM) of Modigliani and Ando (1957) and Ando and Modigliani (1963).[1] The LCM is based on the idea of rational and well-informed individuals who plan their consumption over their entire lifecycle, based on forecasts of their lifetime income.

According to the LCM, the principal motivation for retirement saving is the accumulation of assets to support habitual consumption in retirement. It builds on the empirical observation that per capita aggregate consumption (which we can think of as the consumption of a typical individual) is smoother (i.e., less volatile) than per capita aggregate income (which we can think of as the income of this individual).

The LCM suggests that individuals smooth their consumption over time. The simplest case divides a life into two parts: a period of youth and work, and a period of old age and retirement. In the absence of a pension system, individuals will experience a significant fall in living standards if they have not saved adequately for retirement. It will be hard for them to borrow from others to support future consumption if they have no prospect of future earnings with which to repay loans. Realizing this and naturally not welcoming it, they will plan to reduce expenditure below income when income is relatively high (i.e., when they are young and in work), so as to enjoy higher consumption than income when income is relatively low (i.e., when they are old and retired).

This is called saving for retirement and as a result consumption will be smoother than income. Saving leads to the accumulation of financial assets that are drawn down in retirement. To illustrate the LCM in a world without uncertainty and a zero-interest rate, consider a 25-year-old male who will work for 40 years and be retired for 10 years. He earns $25,000 each year whilst in work so his total human capital or wealth (the present value of his lifetime income) will be $1,000,000.[2] This will be consumed over his 50 years of remaining life. Since he values smooth consumption over his lifecycle, he can spend $20,000 a year and die with all his assets exhausted. To achieve this spending pattern, he saves $5000 a year in a pension plan whilst in work. At retirement, he will have accumulated a pension fund of $200,000, which can be drawn down at the rate of $20,000 a year. Figure 1 illustrates this.

In the real world, matters are more complex than this—pension contributions earn positive returns, and account must be taken of any sums already accumulated. Nevertheless, we can think of retirement savings planning as a mental time travel exercise in which income, consumption and savings are projected forward and current and future needs are balanced one against the other.

2.2. Pension Adequacy in the Real World

In the real world, most people do not behave in the rational way predicted by the LCM—this mental time travel journey is too arduous to undertake and their present needs are too pressing—and hence they generally end up with inadequate pensions.

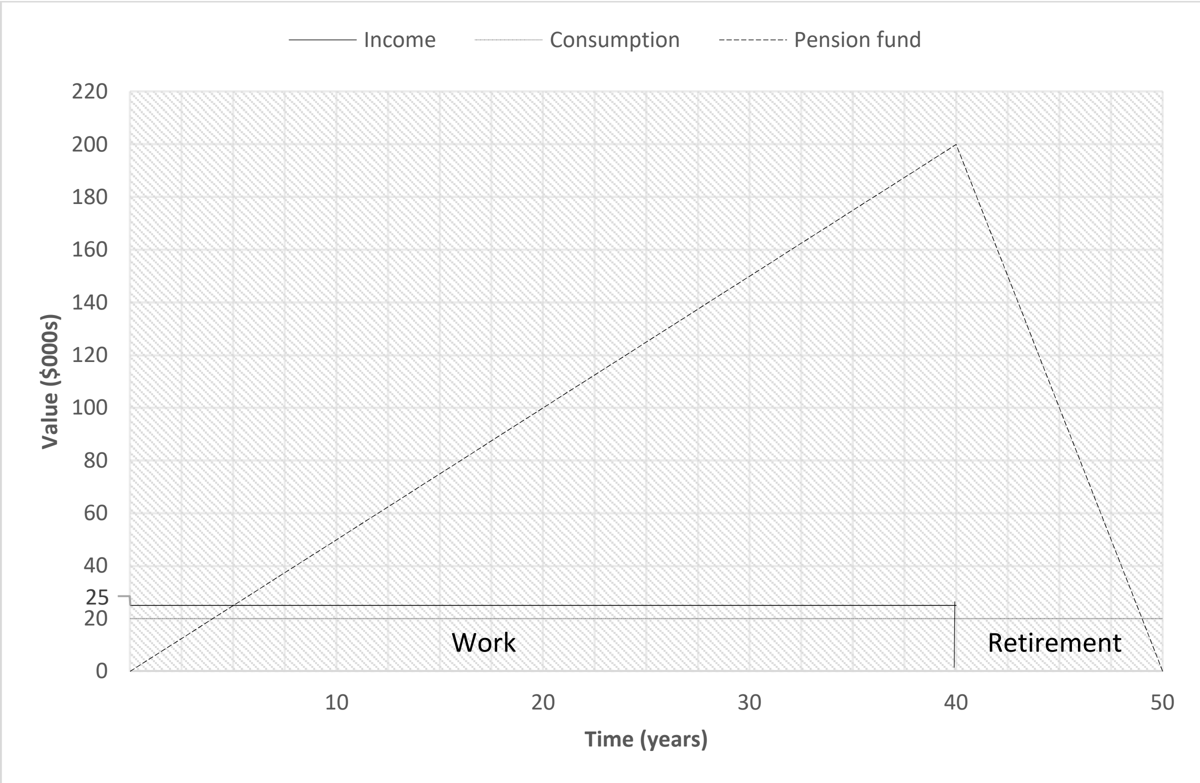

Figure 1. The lifecycle model of consumption with retirement savings in a pension fund.

The European Union's *Pension Adequacy Report 2021* (European Union 2021) defines the adequacy of a pension plan in terms of providing:

- Poverty protection, the ability to prevent and mitigate the risk of poverty in old age, noting that pensions account for four fifths of older households' income;
- Income maintenance, the capacity to replace income earned before retirement and hence limit the financial impact of retirement, thereby maintaining standards of living; and
- Pension/retirement duration. This has two aspects, both of which measure adequacy. First, is whether individuals can afford to spend a reasonable share of their lives in retirement. Second, adequacy changes over the time spent in retirement, reflecting changes in income levels, household composition, health and the need for long-term care.

Using these measures, the EU estimated that around 18.5% (16.1 million) of older persons (aged 65+) were at risk of poverty in the EU-27 in 2019. The rate amongst women was 20.7% and amongst men it was 15.5%. Munnell et al. (2006) estimated that more than 40% of US households were not saving enough to maintain their standard of living into retirement.

The World Bank[3] reports that the situation is even worse in low and middle-income countries: "Traditional family-based care for the elderly has broken down in many developing countries without adequate formal mechanisms to take its place. For the elderly, inadequate transfers from either formal pension systems or from informal family and community transfers can severely reduce their ability to cope with illness or poor nutrition".

Therefore, it is clear that the assumption of rational and well-informed individuals underlying the LCM does not hold in the real world for a significant percentage of the population—probably the majority. We suspect that this is, in large part, because of the ways in which they value the future. Accordingly, in the next two sections, we outline our framework of financial investment valuation as mental time travel and conduct a retirement savings "thought investment".

3. Financial Investment Valuation as Mental Time Travel

Our MTT Framework visualizes financial investment valuation as a journey in which an invested $1 is projected forward in time and the projected value is then discounted back to the present. In this section, we describe three projection methods, three discounting methods and three projecting–discounting combinations.

3.1. Projection Methods

Figure 2 illustrates three projection methods: exponential, hyperbolic, and linear.

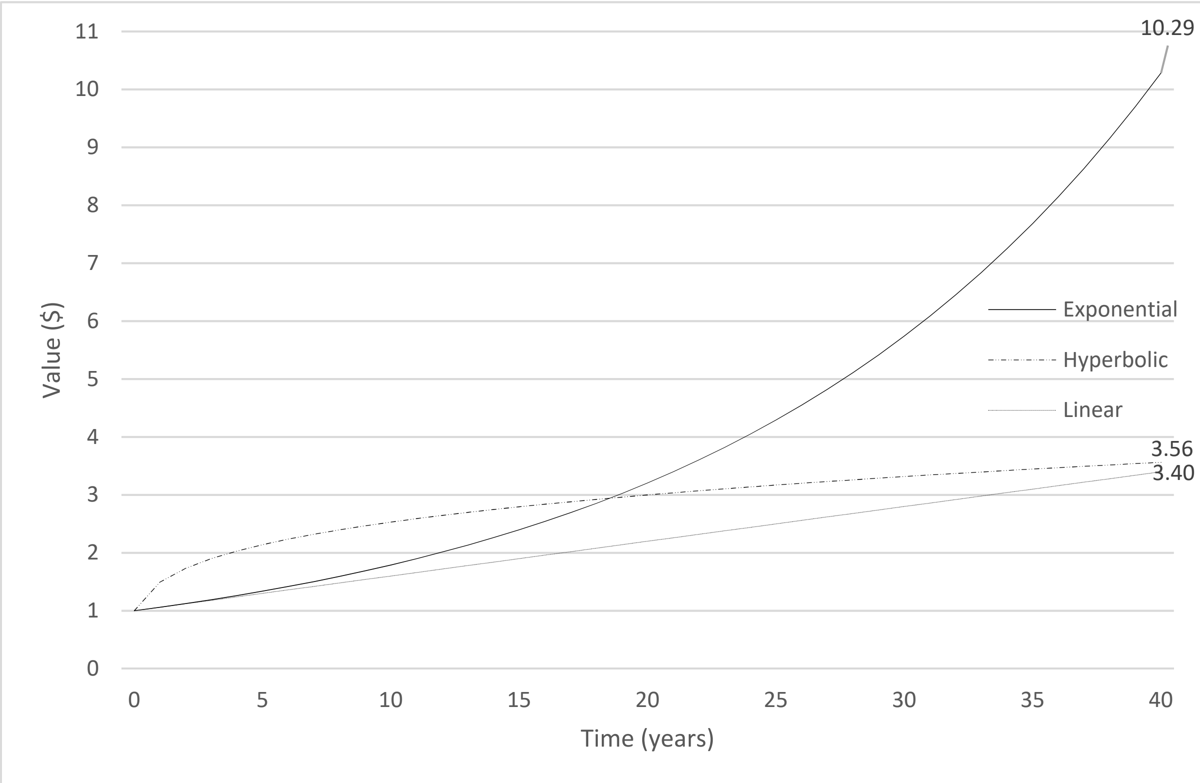

Figure 2. Three projection methods.

3.1.1. Exponential Projection

Exponential projection at a constant growth rate is the standard pension-planning (indeed financial-planning) assumption. Exponential investors, therefore, foresee future values increasing at a constant rate, thanks to the benefits of compounding (Mitchell and Utkus 2004). The exponential curve projects forward 40 years using an exponential (or compounded) return of 6% p.a. to give a value of $10.29.[4]

3.1.2. Hyperbolic Projection

Not all investors project exponentially. Hyperbolic investors, by contrast, expect an invested $1 to grow more rapidly in the short term than in the long term. Therefore, they perceive decreasing benefits to long-term investment—rewards are expected to accelerate quickly and then taper off (Mitchell and Utkus 2004). The hyperbolic curve in Figure 2 reflects this. It rises more rapidly in the near-future (the first five years) than in the far-future (the last five years): it projects forward 40 years to give a value of $3.56.[5]

3.1.3. Linear Projection—Exponential Growth Bias

Research suggests that many people persistently and substantially underestimate the growth of an investment's value over time by neglecting compounding, a phenomenon known as exponential growth bias (Stango and Zinman 2009; Goda et al. 2019). The cognitive source of EG bias appears to be a strong tendency for the brain to linearize functions when extrapolating or forecasting (Stango and Zinman, op cit.). In Figure 2, the linear projection curve neglects the effects of compounding completely. Here, the projection is linear at 6% p.a. for 40 years to $3.40.[6]

3.2. Discounting Methods

Figure 2 can also be read as illustrating three discounting methods: exponential, hyperbolic, and linear. We begin at year-40 and return to the present date.

3.2.1. Exponential discounting

Practitioners typically assume that discount functions are exponential (Angeletos et al. 2001). In Figure 2, a future value of $10.29 is discounted exponentially at 6% p.a. to a current value of $1.[7]

3.2.2. Hyperbolic Discounting

A growing body of experimental evidence suggests that hyperbolic discounting—in which value declines at a more rapid rate in the short term than the long term—better describes how many individuals value delayed rewards (Thaler 1981; Frederick et al. 2002; Laibson 2003; Ainslie 2005; Berns et al. 2007). The hyperbolic curve in Figure 2 reflects this: it falls more rapidly in the near-future (the first five years) than in the far-future (the last five years). In Figure 2, a 40-year ahead payment of $3.56 is discounted hyperbolically to a current value of $1.[8]

This steep discounting of the near-future reflects present bias. Individuals with present-biased preferences are "time inconsistent" and experience "preference reversals"—they value one apple at present over two tomorrow, for example, but prefer two apples in 51 days over one apple in 50 days (Thaler 1981). In other words, they exhibit (apparent) long-term patience, but (definite) short-term impatience.

3.2.3. Linear Discounting

In Figure 2, $3.40 is discounted at a linear rate of 6% p.a. to a current value of $1.[9] Linear discounting suggests an "exponential discounting" bias equivalent to EG bias. We could find no specific reference to such an ED bias in the academic literature, but we suspect that it must exist, given that exponential discounting is at least as complex as exponential projecting. Previous research has found that prospective predictions are easier than retrospective estimates, regardless of the method used, due to the increased difficulty of the maths (Eisenstein and Hoch 2007). On the other hand, extrapolation of exponential series was found to be easier for descending series than for ascending series (Timmers and Wagenaar 1977).

3.3. Symmetry and Asymmetry

Figure 2 can thus be read as containing three pairs of exactly matching projection and discount curves extending from year-0 to year-40 and then back to year-0, one pair being exponential, one pair hyperbolic, and one pair linear. Thus read, each pair of curves traces a mental time travel journey in which an initial value is instantaneously mentally simulated forward and back 40 years. We can see that, when discount rates exactly track projection rates, $1, so invested, has a current personal value of $1. We label this exact matching of discount and projection rates "symmetric valuation". With symmetric valuation, all investments will have present values equal to the cost of $1—regardless of whether they subsequently perform in line with their projected values.

However, personal valuation is not always symmetric. Sometimes, it is asymmetric—discount rates do not exactly match projection rates. Any biases in projection and discounting do not cancel out exactly as is the case with symmetric valuation. Asymmetric valuation can arise both when the methods of projecting and discounting are the same and when they differ. Asymmetric valuation does not preclude the possibility of an invested

$1 having a personal value of $1, but it does greatly reduce its likelihood. We regard the asymmetric personal valuation of retirement savings as a key explanation for pension inadequacy in retirement[10]—as we show in the next section.

It is important to note that in the MTT Framework, the projection of an investment's value and then the discounting of it back to the present date takes place instantaneously, so no real time passes. This, therefore, precludes the possibility that the investor observes deviations between the projected and actual future values of the investment—which might induce revisions of the projection. This is a different issue and, although it is an important one in real world investing, it is not relevant for determining the present value of an investment. Further, we argue that investors must implicitly conduct "thought investments" of the kind we describe here when deciding whether to invest.

4. A Mental Time Travel "Retirement Savings" Thought Investment—The Impact of Exponential Growth Bias and Present Bias

Our saving for retirement illustration in Section 2 assumed a world of certainty and a zero-interest rate. In this case, $1 saved in a pension plan is worth $1 when our saver retires. These assumptions do not hold in the real world, of course. Therefore, our pension-planner needs some idea both of what his invested $1 might be worth when he retires and of what that future value is worth in today's $s. This means he needs to be able to imagine a $1, contributed to his pension fund and invested at the current market value of the financial assets purchased, being projected forward to his retirement date and then discounted back to a present value. In other words, he needs to conduct a mental time travel "retirement savings" thought investment.

Figure 3 is a value-time chart recording a mental time travel journey influenced by the two common biases—EG bias and present bias—that Goda et al. (2019) identify as exercising particularly strong influences on retirement savings decisions. Figure 3 is our illustration of how a pension saver, possessing these two biases—which manifest themselves, respectively, as linear projection and hyperbolic discounting—might value a personal pension contribution of $1 invested for 40 years in a risk-free financial security yielding 6% p.a.

In Figure 3, as in Figure 2, the linear projection curve neglects the effects of compounding completely. The projected value in year-40 is $3.40 rather than the $10.29 it would be if exponentially projected as in Figure 2. The hyperbolic discount curve, in Figure 3, is the same as that in Figure 2, except that it is applied to the linear-projected value of $3.40. The mental time travel journey in Figure 3, combining the effects of EG bias and present bias on valuation, indicates that, for this pension planner, a $1 pension contribution has a personal value of only $0.95.

We can see, furthermore, from the relative steepness of the two curves in Figure 3, that the shorter the time-horizon, the lower the present value. For example, the linear-projected year-1, year-20 and year-39 values are, respectively, $1.06, $2.20, and $3.34, while their present values are $0.71, $0.73 and $0.94, respectively. Therefore, the initial $1 year-0 value exceeds the year-1 present value; but the year-40 present value exceeds the year-39 present value—reflecting the time inconsistency of hyperbolic discounting.

To reiterate, Figure 3 portrays the valuation of retirement savings as mental time travel whereby an initial pension contribution is projected forward and back in time. The forward journey is influenced by EG bias, while the return journey reflects the effect of present bias. As a result, valuation is asymmetric—the invested $1 has a personal or present value of less than $1. As the personal value is less than the value of the proposed pension contribution, the pension planner is unlikely to make the contribution—and hence under-saves for retirement.

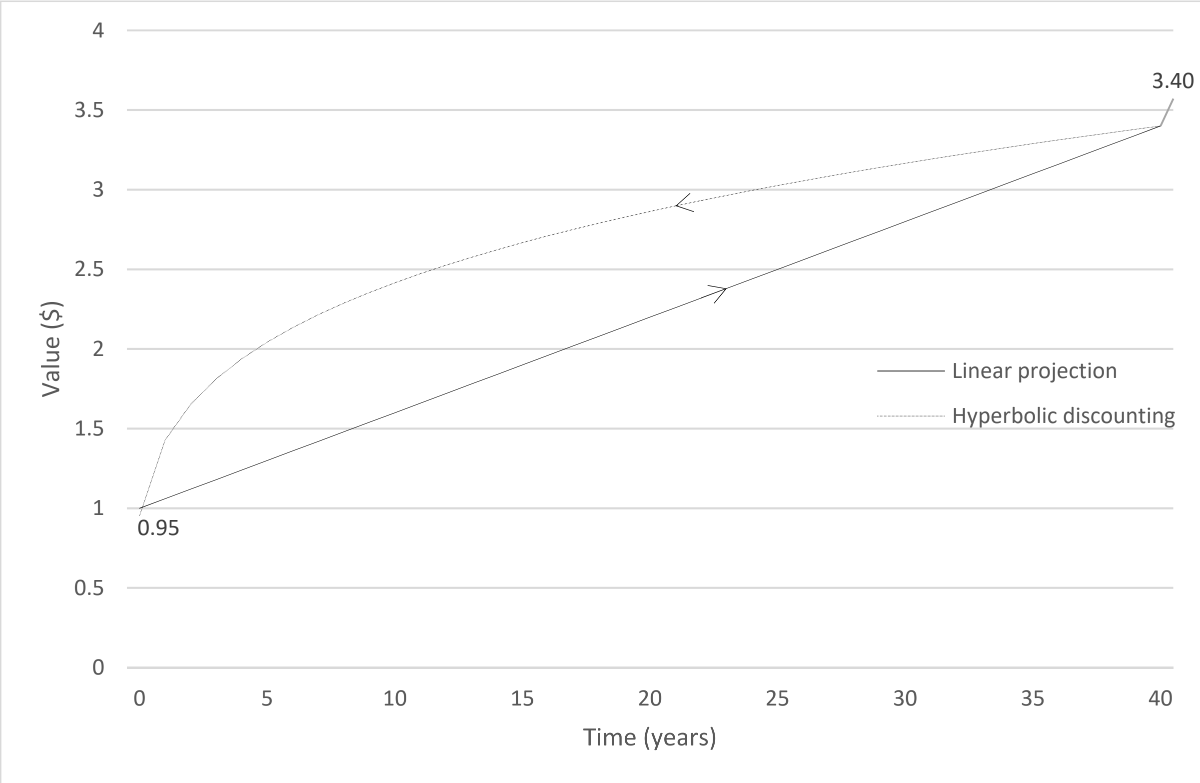

Figure 3. Linear projection with hyperbolic discounting.

It is important to recognize that the personal value of the proposed contribution is less than the initial value entirely because this pension planner is valuing asymmetrically *using a higher average discount rate than the average projection rate* over the 40-year period. The particular projection and discounting methods employed here and the fact that they differ are not by themselves the cause of the undervaluation.

In the next section, we consider some empirical evidence supporting the asymmetric valuation in Figure 3.

5. Empirical Evidence of the Biases and Their Effect on Retirement Savings—And Implications

5.1. Empirical Evidence

Goda et al. (2019) conducted a survey in 2014–2015 that estimated the prevalence of EG bias and present bias in the US population. They tested for EG bias by posing questions about the future value of an asset, given various assumptions, including exponential growth, about the interest rate and time horizon. In other words, they asked how subjects project value. They then tested for present bias by asking subjects how they value receiving various amounts of money over different time horizons. In other words, they posed questions on discounting. Table 1 reproduces the survey's findings. Having one bias was not found to be significantly correlated with having the other bias.

Table 1. Prevalence of exponential growth bias and present bias (%).

		Exponential Growth Bias			
		Most Biased (Linear)	**Some Bias (Underestimate EG)**	**No Bias (Accurate)**	**Some Bias (Overestimate EG)**
Present bias	Not biased	14	17	8	4
	Biased	18	22	12	5

Source: Goda et al. (2019).

Table 1 reveals that of the sample surveyed:

- Only 8% displayed neither bias;
- 12% projected accurately, but were present biased;
- 32% projected linearly, and a further 39% underestimated the effects of compound interest;
- Of those who were not present biased, 14% projected linearly and a further 17% underestimated EG, a total of 31%;
- 9% overestimated exponential growth, of whom 4% had no present bias; and
- 57% were present biased.

EG bias and/or present bias affected the vast majority of the sample. Only 8% were potentially in a position to value financial investments rationally without any external intervention or support.

Other studies give broadly similar findings. For example, another US study by Levy and Tasoff (2016) found that 33% of subjects projected linearly and a further 52% of their sample underestimated compound growth—this compares with 32% and 39%, respectively, in the Goda et al. (2019) study. Similarly, a recent survey in the UK found that, of savers aged 35–54, 50% said they could not afford to contribute more to their pensions (which could be indicative of present bias), 40% felt overwhelmed (which could be indicative of EG bias or, even worse, an inability to conduct any form of meaningful projection or discounting)[11], while only 20% felt on track with retirement planning (Invesco et al. 2021).

5.2. *Implications of the Empirical Evidence and the MTT Framework*

Goda et al. (2019) interpret the evidence in Table 1 as indicating that retirement savings are likely to be low when either EG bias or present bias is operating, and that exhibiting one bias is associated with as much of a reduction in retirement savings as having both biases.

However, our MMT thought investment in Section 4 suggests that the implications are more nuanced—although we need to stress that the MTT Framework focuses on valuation and not decision-making.[12] Figure 3 confirms that asymmetric valuation in which the average discount rate exceeds the average growth rate might act as a disincentive to retirement savings—\$1 of pension savings has a present value of \$0.95. However, Figure 2 suggests that if valuation happens to be symmetric, then there will be no such disincentive, since \$1 saved has a present value of \$1—whatever the investment's duration and *even if* it reflects EG bias and/or present bias.

We are not aware of any empirical studies that assess the symmetry of projection and discounting by investors, except for the study by Eisenstein and Hoch (2007) referred to earlier. However, the asymmetric valuation in Figure 3 seems plausible to us, as do the biases that generated it. Therefore, it would be important to see if and how the biases can be mitigated.

6. Mitigating the Biases

Our MTT Framework implies that the inadequate retirement savings problem[13] is not so much one of the existence of EG bias and present bias, but rather their asymmetric combination—with the average discount rate exceeding the average projection rate. Accordingly, we need to consider how such a combination might be mitigated, even if it cannot be fully overcome. We therefore need to seek out remedies that help to overcome the underestimation of exponential growth and the overstatement of the near-future discount rate.

Mechanisms that have been proposed for overcoming exponential growth bias include:

- Improved financial education, especially in schools (Lusardi and Mitchell 2011, 2014);
- Generic financial guidance—the UK, for example, has introduced a free national guidance service called the Money and Pension Service (MAPS);[14]
- The provision of online retirement income projections or pension calculators, such as that provided by Money Helper in the UK (which is a subsidiary of MAPS);[15]
- Computer-based decision aids and support systems (Arnott 2006);

- Independent financial advice (Stango and Zinman 2009);
- Face-to-face explanations of compounding along with financial advice—Song (2020) showed that this had a large effect on savings in rural China; and
- Tutorials on useful rules of thumb, such as the Rule of 72.[16]

On the basis of Table 1, 80% of individuals,[17] those with some degree of EG bias, would benefit from the provision of accurate projections and those in that category without present bias could thereby be enabled to optimize their retirement savings without further assistance or outside intervention.

To the extent that these support mechanisms encourage recipients to think about their long-term welfare needs, they may also be useful in reducing any excessive discounting of retirement savings. Discount rates have been linked to the degree to which a person feels connected to his or her future self (Hershfield 2011). The concept of a life as a series of psychologically connected temporal selves is a notion developed by philosophers, such as Parfit (1971, 1982, 1984), and explored by economists and behavioral scientists, such as Strotz (1956) and Frederick (2003, 2006). The psychological connections at the core of this concept include our memories, personal characteristics and interests, all of which contribute to the make-up of our personal identity. Research suggests that strong psychological connections between the temporal selves facilitate saving—individuals who anticipate that their future personal identity will overlap considerably with their current identity tend to accumulate more financial assets than do those who sense little such overlap (Hershfield et al. 2009). On the other hand, the more a person's future self feels like a stranger, the more heavily that person might discount that stranger's savings.

However, these support mechanisms are likely to have only a limited impact on increasing retirement savings on a voluntary basis for the majority of people. This is because they do not address present bias–as pointed out by Goda et al. (2014). As noted in Section 3.2.2, present bias leads to hyperbolic discounting, which causes problems when combined with linear or even exponential projection. This is because near-future values are discounted much more steeply than far-future values, which results in the time inconsistency phenomenon whereby, even when long-term value is attractive, short-term considerations discourage investment.

We can demonstrate this with our illustrative 6% p.a. linear-projecting–hyperbolic-discounting $1 potential pension contribution thought investment. For 1-year and 40-year investment horizons, this investment produced future values of $1.06 and $3.40, respectively, but present values of only $0.71 and $0.95. Removing EG bias (and hence projecting exponentially, but still with hyperbolic discounting) increases the 40-year future value to $10.29 and its present value to $2.89, well above the initial $1, but leaves the 1-year investment present value unchanged at $0.71, reflecting the present bias effect (since linear and exponential projection give the same future value of $1.06 after one year). It is likely that the dominance of the present bias effect in the short term will also dominate the thoughts of people contemplating pension savings and put them off. Only by valuing symmetrically will individuals feel that the potential $1 pension contribution is fairly valued at $1.

This helps explain previous research findings that those who discount hyperbolically often procrastinate when considering savings plan enrollment (O'Donoghue and Rabin 1999; Goda et al. 2019). Read et al. (2013) have shown that improved framing can help. For example, they have demonstrated that describing the decision between money now and more money in one year as an interest rate causes people to be more patient.

To address the existence of present bias amongst what is likely to be the majority of the population, governments in several countries have introduced legislation which automatically enrolls individuals into a pension plan when they become employed for the first time. Examples are the US Pension Protection Act 2006 and the UK Pensions Act 2008. Both Acts are based on the Save More Tomorrow Program designed by Richard Thaler and Shlomo Benartzi (Thaler and Benartzi 2004). The program has three components: "First, we ask people to commit now to saving more in the future. This helps them avoid present bias. Second, planned increases in savings rates are linked to future pay raises. This minimizes the influence of loss aversion, since take-home pay never decreases. Third, once employees are enrolled in the program, they remain in the program unless they opt-out. This makes good use of inertia. By taking our mental weaknesses into account, Save More Tomorrow helps us overcome them, allowing workers to make financial decisions closely aligned with their financial needs and long-term goals".[18] While individuals can opt out of the program, very few people do because of inertia (in the UK it is around 9%)[19], which is why the strategy has been called "soft compulsion".

In the UK, the auto-enrollment pension plan began in 2012, with the option of opting out, and the Government set up NEST (National Employment Savings Trust)[20] to take contributions from individuals who were either not able to or did not want to join their employer's auto-enrollment pension plan. The minimum mandatory contributions into an eligible plan is 8% of qualifying earnings, with the employer paying 3% and the employee 5% (although this is reduced to 4% after tax relief). However, it is recognized that 8% of earnings is insufficient to generate a decent pension in retirement. Something of the order of 12–15% is really needed as result of increasing life expectancy and much longer retirement durations than were enjoyed by previous generations.

Accordingly, additional mechanisms have been proposed to "nudge" individuals into increasing their contributions. For example, *Small Steps to a Better Future* (Invesco et al. 2021)—the study referenced earlier, which was commissioned by NEST—has proposed positive messaging to address the three common weaknesses it identified as preventing increased contributions: affordability, a sense of being overwhelmed, and low confidence. The study proposes three "foundational messages that can help people overcome these barriers and take their first steps towards taking action, to make a positive difference to their retirement outcomes":

- "You're already on your way to having a retirement income". Building confidence by emphasizing what they have, including the State pension and any existing pension pots.
- "Start from today and plan forwards". Helping people work from what they know, to understand the gap they need to close.
- "There are steps you can take". Breaking it down into manageable and meaningful actions and showing the difference each step could make to a retirement income.

7. Conclusions

In this paper, we have adapted the Mental Time Travel Framework we developed in Blake and Pickles (2021) for valuing financial investments to address the valuation of retirement savings. Our framework can be used to explain inadequate retirement savings in terms of the asymmetric combination of EG-biased projecting with present-biased discounting. It is our conjecture that it is this asymmetry, in which the average discount rate exceeds the average growth rate (as illustrated in Section 4), that acts as the primary disincentive to retirement savings—a proposed $1 investment having a present value of less than $1—whereas symmetric valuation (as in Section 3) should not do so—$1 saved having a present value of $1 and so is fairly valued.

It is important to reiterate that our retirement savings thought investment (in Section 4) focuses on biases that influence the *valuation of savings*. However, we argue that it is consistent with the findings of previous independent research on the effects of the biases on retirement *savings behavior*. In particular, it complements Goda et al. (2019)'s quantification of the two biases by illustrating the combined effect of the biases on the valuation of a proposed $1 pension contribution. Their analysis reveals a robust association between the biases and the level of retirement savings; our thought investment offers an explanation for why this might be.

These findings, in turn, corroborate evidence that, in many households, financial decisions are determined, not by rational decision makers with sophisticated financial planning skills, but, rather, in the short term, by household members who are surviving from day-to-day. These individuals are not able to set and keep to a weekly budget and so frequently run out of funds before the end of the week and become dependent on very expensive short-term (e.g., pay day) loans to survive until the next pay day (another result of EG bias with the cost of compound interest—often as high as 3000% p.a.—being underestimated or simply ignored). It is even more challenging for such households when it comes to long-term financial decision making like pension planning, especially when their members have a weak temporal connection with their future selves.

Accordingly, we considered some solutions for overcoming the effects of the two biases. Goda et al. (2019) suggest that in the US: only about 12% of the population could be saving adequately for retirement without any external support or intervention;[21] and that a further 31%—those with EG bias, but not present bias—should benefit from education and illustrative retirement income projections. EG bias is perceptual and is therefore easier to remedy—since perceptual errors can in principle be corrected by education, guidance or advice—than is present bias, which is a preference[22] that appears to be deeply embedded since it is habitual. The most effective solution for the 57% of the population with present bias seems to be auto-enrollment.

Goda et al. (2019) estimated that if the EG and present biases could be eliminated completely, retirement savings could increase by 12%. Levy and Tasoff (2016), on the other hand, are more optimistic: they estimated that removing the EG bias by itself could increase accumulated assets by between 55 and 90%. Applied to the UK minimum auto-enrollment employee contribution of 5%, removing both biases could increase total pension contributions by 0.6 percentage points to 8.6% if the estimate of Goda et al. (2019) is correct, while just removing EG bias would increase contributions by 4.5 percentage points to 12.5% if the most optimistic of the estimates of Levy and Tasoff (2016) is correct (and the 3% employer's contribution is also included in both cases). Therefore, eliminating the two biases would be one of the "steps you can take" to increase retirement savings and thereby move closer to receiving an adequate pension in retirement.

We end with two remarks. First, it is important to recognize that there are perceptions other than EG bias (such as time perception) and preferences other than present bias (such as loss aversion) that influence the valuation of retirement savings;[23] there are factors other than valuation (such as the availability of financial resources) that contribute to inadequate retirement savings; and there are elements of the pension planning process other than the accumulation of retirement savings that need to be taken into account (such as their decumulation).[24] However, we believe we have highlighted in this paper the effects of two of the key causes of inadequate retirement savings and that capturing their effects in a mental time travel thought investment is an instructive way to illustrate their relative and combined effects and thereby highlight the true nature of the retirement savings challenge–as well as offering solutions for addressing these challenges.

Second, it is important to get a good fix on the size of the effects of EG and present biases on retirement savings. The empirical studies of Goda et al. (2019) and Levy and Tasoff (2016) revealed wide differences in their estimates of the size of the impact of EG bias, for example. Further research is needed to narrow down these estimates. This would be helpful for assessing the relative efficacy of educational support mechanisms and advice versus nudging and soft compulsion.

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Notes

1 We cite here only the original LCM studies, although we recognize that there have been many extensions of the LCM since then, including allowances for income risk, liquidity constraints, bequests, family formation and dissolution, each of which can influence retirement savings.

2 When the interest rate is zero, we can simply sum up the annual earnings over the 40 years of the working life.

3 https://www.worldbank.org/en/topic/pensions (accessed on 2 December 2021).

4 We use the formula $(1 + r)^T$ to define the exponential projection function for a T-year investment horizon. Figure 2 assumes that $r = 6\%$.

5 We use the formula $(1 + \alpha T)^{\gamma/\alpha}$, where γ and α are constants, to define the T-year hyperbolic projection function (Loewenstein and Prelec 1992; Laibson 1998). Figure 2 assumes $\gamma = 1$ and $\alpha = 4$.

6 We use the formula $(1 + rT)$ to define the linear projection function for a T-year investment horizon (i.e., simple interest is applied). Figure 2 assumes that $r = 6\%$.

7 We use the formula $(1 + r)^{-T}$ to define the T-year exponential discount function. Figure 2 assumes that $r = 6\%$.

8 We use the formula $(1 + \alpha T)^{-\gamma/\alpha}$ to define the T-year hyperbolic discount function (Loewenstein and Prelec 1992; Laibson 1998). Figure 2 assumes that $\gamma = 1$ and $\alpha = 4$.

9 We use the formula $-r(T - t)$ to define the T-year linear discount function, so the discounted value of the year-40 value of \$3.40 will follow the linear path \$3.40-$r(T - t)$, for t = T, T − 1, T − 2, . . . , 1, 0 from year-40 back to the current date. Figure 2 assumes that $r = 6\%$.

10 It is not the only explanation, of course, since as one of the referees for this paper pointed out "simply observing that many old people are in poverty is not a proof of lack of saving: many people are lifetime poor, and their consumption is unfortunately low before and after retirement".

11 To confirm this possibility, Levy and Tasoff (2016) found that 33% of their US sample reported total pension savings below the sum of contributions, while 26% of their sample failed to provide the correct answer to the question "what is the value of \$100 investment at the end of one year when the interest rate is 4%?".

12 We look to other studies, such as that of Goda et al. (2019), for evidence that biases in valuation influence decision making.

13 For those not living in extreme poverty.

14 https://maps.org.uk (accessed on 2 December 2021). Note that guidance differs from advice—and this is an important distinction in a UK financial regulatory context.

15 https://www.moneyhelper.org.uk/en/pensions-and-retirement/pensions-basics/pension-calculator (accessed on 2 December 2021).

16 The Rule of 72 shows the number of years it takes to double the value of an investment that grows with compound interest (Years to Double = 72/Interest Rate) and is reasonably accurate for interest rates in the range 6–10% (https://www.investopedia.com/terms/r/ruleof72.asp (accessed on 2 December 2021).

17 Above the poverty threshold.

18 http://www.shlomobenartzi.com/save-more-tomorrow (accessed on 2 December 2021).

19 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/227039/opt-out-research-large-employers-ad_hoc.pdf (accessed on 2 December 2021).

20 https://www.nestpensions.org.uk (accessed on 2 December 2021).

21 Invesco et al. (2021) suggests this could be 20% in the UK.

22 Since it improves immediate welfare or utility.

23 Furthermore, as helpfully pointed out by one of the reviewers of this paper, "there may be circumstances where growth and discount rates differ for understandable reasons such as when individuals have a normal (e.g., 6%) return on investments but face interest rates of, say, 15% or more on credit card debt or payday loans".

24 We discuss some of these issues in more detail in Blake and Pickles (2021).

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