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Reexamining "to versus through"

New research into an
old debate

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Executive summary

- “To versus through” has become shorthand for whether a target date fund glidepath should evolve only until the target date (“to fund”) or continue to reduce the risk level beyond the target date (“through fund”). Whatever the merits of either approach, “to versus through” should be understood as expressing different philosophies about how assets should be invested after a participant ceases to earn a paycheck.
- It is BlackRock’s position that a persuasive common sense case can be made for the “to fund” approach based on an understanding of human capital, or the ability to earn income, which is depleted at retirement, and retirement risk, which we argue is at its highest level the day retirement begins. In addition to making the common sense case, this paper also explores the question through the lens of new BlackRock research.
- This research, which is described in the paper, attempts to create a unified framework for exploring a wide range of lifecycle investing questions. It builds on a substantial body of academic work and seeks to incorporate investor preferences, validated against real-world income and spending data. In addition to producing suggestions regarding equity levels, savings rates, and retirement withdrawal strategies, the research adds empirical force to the argument that a flat post-retirement glidepath is superior to a glidepath that continues to de-risk beyond the retirement date.

Reexamining “to versus through”

What new research tells us about an old debate

“To versus through” has been used to differentiate target date funds almost since the day they were introduced. “To funds” are those with a managed glidepath only until the day of retirement, after which they assume a static asset allocation. The equity level of “through funds” continues to roll down well beyond the target date. The former were presumably designed for participants who would roll out of their DC plan at retirement, while the latter, by virtue of their evolving post-retirement glidepath, were designed to provide investment management throughout retirement.

The phrase “to versus through” is something of a misnomer, however, as managers of both types of funds typically expect to manage participant assets during accumulation and after retirement regardless of the post retirement glidepath. Other reasons for classifying funds as “to” or “through” have been offered, most notably as shorthand for the risk level at the target date. That reason also fails to stand up to scrutiny because there are a wide range of risk levels across both classifications.

What “to versus through” should be understood to express, however, is a differing philosophy about how assets should be invested after a participant ceases to earn a paycheck. This is an important, even critical, question. Retirement is a new phase in which participants must now depend on their accumulated capital for the majority of their living expenses—ideally, capital acquired steadily over their careers. Do participants need additional allocation changes after this transition or should the target date fund glidepath stop gliding at retirement?

We believe that once the forces driving the glidepath are properly understood, a persuasive ‘common sense’ case can be made that a target date fund should reach its equity landing point at retirement. In this paper, we will make that case, but we will also take the opportunity to explore the question of “to versus through” using new BlackRock research.

The goal of the research, which we will also detail in this paper, is to create a single unified framework for exploring a wide range of lifecycle investing questions. The research builds on a substantial body of academic work and seeks to incorporate investor preferences, validated by real-world income and spending data, into a single framework. The research was not developed solely, or even principally, to explore “to versus through”. We are bringing it to this debate for two reasons. First, we believe that the rigorous financial economics and theory supporting the model clearly illustrate the shortcomings of the “through fund” glidepath. The second reason is that the “to versus through” debate offered us an opportunity to demonstrate the framework’s value by answering and moving the debate past a persistent question.

Looking beyond “to versus through”, the broader need for this research is clear. Anyone seeking sound retirement planning advice will quickly discover that the financial press is awash with various (and often contradictory) examples of advice, opinions, and rules-of-thumb for how much people should save, how they should invest their savings, and how they should spend those savings in retirement. It is no wonder then that, according to a survey by the Employee Benefits Research Institute, 28% of workers are not at all confident that they will have enough money for a comfortable retirement.¹ They lack actionable answers to basic retirement questions.

Ultimately, we believe our research can shed light on three essential, interrelated questions that individuals, plan sponsors, and investment managers need to understand to meet individuals’ retirement needs. These questions are:

- How much should I save during my career?
- How should I invest my savings?
- How should I spend my savings in retirement?

We start, however, by discussing the common sense case against the “through fund” glidepath.

¹ The 2013 Retirement Confidence Survey: Perceived Savings Needs Outpace Reality for Many, EBRI.

Risk and human capital:

The common sense case

Let's begin with a question: why should a glidepath change at all? Target date funds are now so commonplace that it is difficult to recall that they were once controversial. In fact, it took nearly a decade after their introduction for target date funds to begin to gather substantial assets. In part, the relatively slow adoption of target date funds was a result of a conviction (supported by some academic research) that individual risk tolerances do not change over time. If that's the case, why would an investor need a fund that reduces risk on his or her behalf over time? The answer is found by looking at factors external to an individual's risk preferences.

The retirement date: The riskiest day of your life

Financially speaking, what is the riskiest day of your life? We believe it is the day you retire. This may come as a shock to someone who feels like he or she have crossed the finish line of retirement with a sizable nest egg in hand. But consider these three things:

- You built your nest egg by saving part of your income. However, without future earnings to offset investment losses you may be forced to reduce spending in the event of a market downturn.
- Since you will now begin drawing down your financial wealth as retirement income, your wealth is most likely at its lifetime peak. And that, in turn, means the impact of investment losses will never be larger.
- You face the longest retirement time horizon possible. A loss now can have the greatest impact on your ability to sustain spending throughout retirement.

If the day you retire is so risky, shouldn't correctly setting your portfolio risk on that day be the single biggest concern? Of course, different target date fund providers and plan sponsors may have differing views of how much risk is appropriate at retirement. They may be perfectly justified in having these different views, but the amount of risk taken at the target date should be the lowest risk point on the glidepath. What is the rationale for taking more risk at the beginning of retirement than at some point years in the future when account balances are likely to be smaller and the planning horizon is shorter?

Some "through fund" managers justify their approach by citing evidence that people are living longer. It could be argued

that the fact of increasing longevity may warrant taking more risk throughout retirement, but it's not a valid argument for taking more risk at retirement and less risk later. In fact, a longer lifespan makes the post-retirement planning horizon longer, which increases risk at the retirement date. Prescribing a riskier portfolio at this date to counteract what is already the riskiest point of a person's life is a puzzling approach. Arguing for a "through" glidepath represents, to us, a fundamental misunderstanding as to why target date funds make sense at all.

Human capital: The fundamental reason for glidepath

Human capital is the term we use to describe our ability to earn income; you can think of human capital as the present value of all future expected earnings. Like a bond, human capital offers steady income on a regular basis, typically through paychecks. Each paycheck transfers a portion of our human capital into financial capital, most of which we spend, but some of which we save for retirement or other future spending needs. As we age, our total wealth (i.e., human capital plus financial capital), gradually shifts from being predominantly composed of bond-like human capital to predominantly financial capital.

The rationale for changing portfolio risk as we age is not due to a shift in individual risk tolerances. It is due to the shift in wealth composition from human capital to financial capital. Once human capital is exhausted, that is, once we have no more future earnings, the rationale for evolving the glidepath and shifting asset allocation with age ceases. In other words, a glidepath should stop gliding at retirement.

One argument that has been made by the proponents of the "through fund" model is that even when people retire they still have the ability to reenter the workforce and therefore their human capital is not fully depleted. That is true, but that is merely changing the definition of retirement. Target date funds are designed to target a retirement date, not an arbitrarily chosen birthday. A 65-year old with a job is not really retired, while a 65-year old living off his accumulated financial capital is retired. Both need to select the target date fund that corresponds with the year they plan to actually retire, whatever that year may be. And assuming they choose the fund for the year they retire, it is difficult to see the benefit of a glidepath that continues to reduce risk beyond the target date.

Spending, saving, investing:

Towards an optimal lifecycle model

As we have seen, a persuasive case for a flat post-retirement glidepath can be made based on a common sense understanding of retirement risk and human capital. Does this case stand up to rigorous scrutiny and economic theory? There is a large body of academic research that suggests it does (see the references for an extensive list). Nonetheless, we developed our own research to test “to versus through” and a wide range of other lifecycle investing questions. This is by necessity a technical discussion, but we present it here in non-technical terms with some of the more technical details offered in an appendix. We believe an optimal lifecycle model consists of three components:

- **A utility function that describes investor spending preferences.** This utility function captures three generalized facts about human nature. First, people generally enjoy more spending rather than less. Second, there tends to be a decreasing marginal benefit to additional spending. In other words, people tend to derive less enjoyment from each additional dollar they spend. Third, people tend to prefer immediate spending to delayed spending (i.e., it is difficult to delay gratification). Additionally, our utility function accounts for several other important factors that may influence investor preferences such as life expectancies and people’s desire to leave wealth behind for their heirs. The utility function that we use is common in this type of research.²
- **A specification of how labor income patterns evolve over time.** Income typically exhibits a hump-shaped pattern over the course of a career: increasing early on, peaking in one’s 40’s or 50’s, and decreasing somewhat as retirement approaches. We can capture this pattern as well as the impact of random and unpredictable fluctuations in income due to economic shocks and individual circumstances.³
- **A set of constraints.** Constraints include limitations on borrowing and a budget constraint dictating how wealth evolves from period to period accounting for cash flows and returns.

The utility function and the income data enable our model to capture individual behaviors through their preferences (i.e., their attitudes towards risk). We use that data to produce an optimal asset allocation and suggested saving and spending strategies to smooth spending patterns over the lifecycle.

Simply put, savings and drawdown rates are the output—that is, conclusions we are able to draw based on the data, rather than assumptions needed to build the model.

Let’s describe the various factors that are considered in our model in more detail.

The utility function—quantifying investor spending preferences

Economists use utility to refer to the “satisfaction” or “enjoyment” derived from consuming goods and services. Utility serves as a way of quantifying the risk/return tradeoff individuals face and forms the foundation upon which modern economics is built. Generally, individuals derive more enjoyment from additional consumption, but as consumption increases they derive less enjoyment from each additional dollar consumed. Furthermore, individuals tend to prefer immediate gratification over delayed gratification, and prefer smoothing consumption over time. The utility function helps us capture these various investor spending preferences and allows us to quantify the tradeoffs between risk and return, as well as between immediate spending and saving to support spending in the future.

The labor income process—the importance of human capital

Perhaps the single most important factor affecting an individual investor’s well-being is labor income. All of the goods and services an individual consumes over his or her lifespan (excluding gifts) are purchased using labor income or investment returns earned on saved labor income. Therefore, the characteristics of labor income play a critical role in determining the optimal saving, spending, and investment strategy that an individual should pursue.

In addition to the hump-shaped pattern described above for lifetime income, national income data shows that incomes are also affected by education level, occupation, and random fluctuations. These may be specific to the individual or may be due to more general economic conditions in the labor market. Understanding how labor income changes over time can have important implications for efficient saving, spending, and investment decisions.

² See Epstein and Zin (1989) for details.

³ The data that we use to estimate the labor income process is the University of Michigan Panel Study of Income Dynamics dataset.

The individual investor's budget constraint

Simply stated, the amount of money individuals have at the end of the year is equal to the cash they took in, minus the cash they spent, plus returns on savings, added to whatever financial capital they had at the beginning of the year. This may sound trivial, or perhaps an obvious point, but it plays a crucial role in how individuals spend their money throughout their life. Generally, people receive cash inflows in the form of paychecks throughout their career, some of which they will choose to spend, and some of which they will choose to save and invest to fund future expenditures. Individuals have to strive to balance out their desire for current spending versus their need to fund future spending when they no longer collect income from employment. This inextricable link between current and future spending is captured in the budget constraint.

Implications of the model

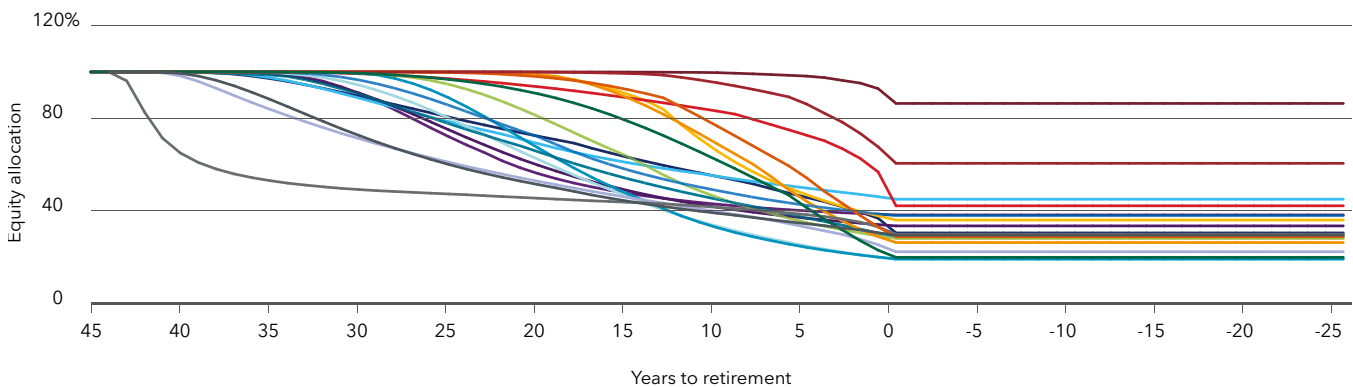
The model allows us to create strategies that help maximize and smooth the enjoyment an individual gets from spending throughout their lifecycle, including during their career and in retirement. The result is an optimal investment strategy, shown as a glidepath, and an optimal strategy for saving during one's career and drawing down one's assets in retirement. These can be distilled into actionable lessons.

Lesson 1: The optimal investment strategy is to be fully invested in equities early in your career, gradually decrease equity exposure in the middle of your career, and maintain a constant equity allocation throughout retirement.

As was highlighted earlier, young investors have large implicit human capital holdings early in their career and virtually no financial capital. As a result they can take considerable risk with their financial capital in order to earn the higher premium offered by equities during this phase of their lifecycle, allowing them to capture as much potential growth as possible early on. This is true for a wide range of investor preferences, labor income characteristics, and capital market assumptions. As human capital is depleted and financial capital grows, the optimal allocation to equities decreases, eventually reaching its lowest level at the retirement date.

This brings us back to our earlier discussion of the "to versus through" debate. We find that **under any set of assumptions about investor risk preferences, capital markets or labor income characteristics, it is always optimal to have a flat post-retirement glidepath.**⁴ To make this point concrete, Figure 1 below shows the resulting glidepaths for a number of random assumptions, some of which may be more or less realistic than others.

Figure 1: Optimal glidepaths for various assumptions about risk preferences, capital markets and labor income



Sources: BlackRock, for illustrative purposes only.

⁴ This is true if individuals' utility functions are of the constant relative risk aversion (CRRA) class. Campbell and Viceira (2002) argue that the large increases in per capita consumption and wealth experienced over the last two centuries, combined with a lack of corresponding trends in risk premia or interest rates over this period, implies that risk aversion cannot depend strongly on wealth, providing evidence that individuals exhibit constant relative risk aversion.

However, in all of these cases (and we have examined hundreds in addition to these), the evidence on the “to versus through” argument is unanimous: a “to” glidepath always makes sense.

In some ways the results shown in Figure 1 should not come as a surprise. In 1969, Nobel laureates Robert Merton and Paul Samuelson each independently demonstrated in their groundbreaking papers that in the absence of labor income the optimal strategic asset allocation is constant, with the amount of risk reflecting individual risk aversion.⁵ This fact remains as true now as it was then, which is why the idea of a “through” glidepath is so puzzling. It is also interesting to note that while a participant in a “through fund” may potentially benefit from a higher equity allocation early in retirement if the market is positive, reducing the equity allocation the year following a market loss could leave them poorly positioned to capture a potential market rebound.⁶

So far we have not considered the impact that sources of post-retirement income, such as defined benefit pensions or Social Security, might have on the optimal investment strategy. Increasingly fewer people have a defined benefit pension to fund their retirement, and while most Americans will receive Social Security payments, there are numerous variables around when they may start to receive payments and the income replacement the payments will provide. The safer, more conservative approach, we believe, is to leave such payments out of our model.

What is astonishing, however, is that if we choose to include assumptions about these payments, **the case for a “through” glidepath looks even weaker.** In fact, when guaranteed retirement income is included, the optimal strategy is to increase the equity allocation throughout retirement; reducing equity in retirement is actually the opposite of what is optimal. To understand why this is so, our human capital discussion provides insight. Similar to human capital, post-retirement income is bond-like in nature. As retirees draw down their financial assets and account balances get smaller, their overall wealth becomes composed of more and more bond-like benefit payments, allowing their financial assets to shift back towards equities to offset this shifting wealth composition. Essentially, this is the same as the argument for a declining equity allocation

during your career, but is reversed since now financial assets are decreasing rather than increasing relative to a bond-like non-tradable asset. In light of this, plan sponsors, acting as fiduciaries on behalf of their participants, should consider asking how “through” glidepath providers justify their investment decision to continue to reduce risk during the retirement period. While this may seem counterintuitive, our findings are consistent with those of other researchers.⁷

Lesson 2: Individuals should save between 10% and 20% of their income every year.

One of the other benefits of our model is that it provides suggestions regarding saving and spending patterns over the lifecycle. We find that while optimal saving rates depend on age and realized returns, and generally increase as salaries increase during the early years of a typical career, on average the optimal savings rate is between 10% and 20% of annual income. Unfortunately many DC plans currently auto-enroll employees at 3%⁸ of pay with some degree of matching contribution, resulting in savings far below what is needed to sustain spending throughout retirement. In the partnership among participants, plan sponsors, and investment managers, with the goal of helping individuals secure a comfortable retirement, plan sponsors play a critical role in light of their unique position in encouraging higher savings rates via DC plans that include “auto” features and matching contributions designed to drive increased deferrals.

Lesson 3: The optimal retirement withdrawal strategy is dynamic.

Withdrawing a fixed annual amount following retirement may cause two potential problems. The first is spending down all your assets prematurely and the second is its opposite, leaving a large unspent surplus. By withdrawing an amount proportional to the current market value of assets, the individual will not prematurely run out of money. As time passes, this proportion can increase to reflect the shrinking retirement horizon. Individuals who want to spend a consistent amount should consider a more conservative asset allocation throughout retirement or even consider guaranteed income products like annuities to hedge the risk of outliving their savings.

⁵ See Merton (1969) and Samuelson (1969) for details. ⁶ This point is also made by Blanchett (2007) and Cohen, Gardner, and Fan (2010). ⁷ See, for example, Campbell and Viceira (2002), Cocco, Gomes, and Maenhout (2005), Gomes, Kotlikoff, and Viceira (2008), Gomes and Michaelides (2003), and Gomes and Michaelides (2005). ⁸ See, for example, Notes, September 2012, Vol. 33, No. 9, Employee Benefit Research Institute, page 12.

After “to versus through”

As we stated elsewhere in this paper, different target date fund providers and plan sponsors may have differing views of how much risk is appropriate at retirement. They may have different views regarding the objective of target date funds or the range of asset classes that should be included within a glidepath. But those decisions are independent of the post-retirement glidepath. Regardless of a target date fund provider’s conviction about the appropriate risk level at retirement, it is hard to find a rationale for taking more risk on the retirement date than at a later date when account balances are likely to be smaller and the planning

horizon is shorter. Similarly, it is difficult to understand on what basis a glidepath should continue to reduce risk after human capital has been exhausted.

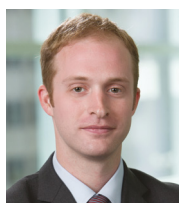
While the common sense case against the “through fund” glidepath is itself persuasive, the rigorous support for this conclusion provided by our model, and supported by academic research, should finally lay the question to rest. More importantly, exploring the question has shown that our unified framework provides a robust approach for exploring a wide range of lifecycle investment questions.



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Technical appendix:

Mathematical details of the model

In this appendix we briefly describe a comprehensive strategic asset allocation model for the individual investor.

Investor preferences

Letting C_t and X_t denote consumption and wealth at time t , respectively, we assume investor preferences are described by Epstein-Zin⁹ utility according to the recursive relationship:

$$1 \quad V_t = \left\{ (1 - \delta) C_t^{1-1/\psi} + \delta E_t [p_t V_{t+1}^{1-\gamma} + b(1 - p_t) X_{t+1}^{1-\gamma}]^{\frac{1-1/\psi}{1-\gamma}} \right\}^{\frac{1}{1-1/\psi}}$$

where γ is the coefficient of relative risk aversion, ψ is the elasticity of intertemporal substitution, δ is the subjective discount factor, b is the strength of the bequest motive, and p_t is the conditional survival probability from t to $t+1$.¹⁰ Given the presence of a bequest motive, the terminal value of the recursive utility function in the final period T is:

$$2 \quad V_T = \left[(1 - \delta) C_T^{1-1/\psi} + \delta (b X_{T+1}^{1-\gamma})^{\frac{1-1/\psi}{1-\gamma}} \right]^{\frac{1}{1-1/\psi}}$$

In the absence of a bequest motive, it is optimal to consume all remaining wealth in the final period.

Labor income process

We follow the standard specification in the literature and define the labor income process prior to retirement for individual i by:

$$3 \quad \log(Y_{i,t}) = f(t) + P_{i,t} + U_{i,t}$$

$$4 \quad P_{i,t} = P_{i,t-1} + N_{i,t}$$

where $f(t)$ is a deterministic function of age that can be calibrated to capture the hump shape of income over the lifecycle, $P_{i,t}$ is a permanent component with random shock $N_{i,t} \sim N(-\sigma_N^2/2, \sigma_N^2)$, and $U_{i,t} \sim N(-\sigma_U^2/2, \sigma_U^2)$ is a transitory random shock. We assume that the permanent and transitory shocks to labor income are uncorrelated. Lastly, we assume individuals retire at age 65 and we allow for the possibility of a fixed, real income stream in retirement

expressed as a percentage of final period labor income. This can be used to represent Social Security payments or benefits accrued through a defined benefit pension plan. Expressed mathematically, given a retirement year of $t=K$, post-retirement income can be expressed as a constant fraction λ of permanent labor income in the last working year:

$$5 \quad \log(Y_{i,t}) = \log(\lambda) + f(K) + P_{i,K} \quad \text{for } t > K$$

Financial assets

We assume that the investment opportunity set is constant and that there are two risky financial assets, stocks and bonds, with expected log returns distributed as $N(R^S - \sigma_S^2/2, \sigma_S^2)$ and $N(R^B - \sigma_B^2/2, \sigma_B^2)$, respectively. We allow stocks and bonds to be correlated with the correlation coefficient ρ_{SB} . We also allow for stocks to be correlated with the permanent component of labor income with correlation coefficient ρ_{SN} .

Wealth accumulation and budget constraint

We denote wealth, X_t , as the liquid wealth available for funding consumption and savings. At each point in time the investor has to decide how much to consume and how to allocate wealth among stocks and bonds. At the beginning of each period investor i starts with wealth $X_{i,t}$. Then labor income $Y_{i,t}$ is realized. At this point the investor must choose how much to consume and how to allocate the remaining wealth among the available assets. Therefore the budget constraint is:

$$6 \quad X_{i,t+1} = Y_{i,t+1} + (X_{i,t} - C_{i,t})(\alpha_{i,t} R_{t+1}^S + (1 - \alpha_{i,t}) R_{t+1}^B)$$

where $\alpha_{i,t}$ is the fraction of wealth invested in stocks.

⁹ Epstein-Zin utility is a constant relative risk aversion (CRRA) utility function that has the feature that risk aversion and the elasticity of intertemporal substitution (EIS) are disentangled from each other. Power utility is a special case of Epstein-Zin utility where $\gamma=1/\psi$. ¹⁰ Mortality rates sourced from the Blended Annuity 2000 Mortality Table, Society of Actuaries.

The investor's optimization problem

The investor's optimization problem is to maximize the expected utility of consumption over the entire lifecycle:

$$7 \quad \max_{\{\alpha_{i,t}, c_{i,t}\}_{t=0}^T} E[V_0]$$

where V_0 is determined by the recursive utility function described by Equations (1) and (2), subject to the constraints given by Equations (3) through (6).

Analytical solutions to this problem do not exist and we must use numerical solution methods to arrive at the optimal decision rules for consumption and portfolio choice. The solution consists of optimal consumption and portfolio allocation policies as functions of wealth and age. In order to obtain unconditional optimal consumption and portfolio allocations as functions of age alone, we simulate a large number of agents following the optimal conditional policies and take cross-sectional means to arrive at the optimal expected spending (and consequently saving) policies and the optimal asset allocation as functions of participant age.

References:

Academic research

- Blanchett, D. M. (2007)**, "Dynamic Allocation Strategies for Distribution Portfolios: Determining the Optimal Distribution Glide Path," *Journal of Financial Planning*, 20 (12), 68-81.
- Bodie, Z., R. C. Merton, and W. F. Samuelson (1992)**, "Labor Supply Flexibility and Portfolio Choice in a Life-Cycle Model," *Journal of Economic Dynamics and Control*, 16, 427-449.
- Bodie, Z., J. Treussard, and P. Willen (2007)**, "The Theory of Life-Cycle Saving and Investing," Public Policy Discussion Paper 07-3, Federal Reserve Bank of Boston.
- Campbell, J. Y. and L. M. Viceira (2002)**, *Strategic Asset Allocation: Portfolio Choice for Long-Term Investors*. Oxford University Press.
- Carroll, C. D. and A. A. Samwick (1997)**, "The Nature of Precautionary Wealth," *Journal of Monetary Economics*, 40, 41-71.
- Chai, J., W. Horneff, R. Maurer, and O. Mitchell (2012)**, "Optimal Portfolio Choice over the Life-Cycle with Flexible Work, Endogenous Retirement, and Lifetime Payouts," *Review of Finance*, 15 (4), 875-907.
- Cocco, J. F., F. J. Gomes, and P. J. Maenhout (2005)**, "Consumption and Portfolio Choice over the Life Cycle," *The Review of Financial Studies*, 18 (2), 491-533.
- Cohen, J., G. Gardner, and Y. Fan (2010)**, "Should Target Date Fund Glide Paths be Managed 'To' or 'Through' Retirement?," *Russell Investments*.
- Dynan, K. E., J. Skinner, and S. P. Zeldes (2002)**, "The Importance of Bequests and Life-Cycle Saving in Capital Accumulation: A New Answer," *American Economic Review*, 92, 274-278.
- Epstein, L. and S. Zin (1989)**, "Substitution, Risk Aversion, and the Temporal Behavior of Consumption and Asset Returns: A Theoretical Framework," *Econometrica*, 57 (4), 937-969.
- Gomes, F. J., L. J. Kotlikoff, and L. M. Viceira (2008)**, "Optimal Life-Cycle Investing with Flexible Labor Supply: A Welfare Analysis of Life-Cycle Funds," *American Economic Review: Papers and Proceedings*, 98, 297-303.
- Gomes, F. and A. Michaelides (2003)**, "Portfolio Choice with Internal Habit Formation: A Life-Cycle Model with Uninsurable Labor Income Risk," *Review of Economic Dynamics*, 6, 729-766.
- Gomes, F. and A. Michaelides (2005)**, "Optimal Life-Cycle Asset Allocation: Understanding the Empirical Evidence," *The Journal of Finance*, 60 (2), 869-904.
- Gourinchas, P., and J. A. Parker (2002)**, "Consumption Over the Life Cycle," *Econometrica*, 70 (1), 47-91.
- Horneff, W., M. Raimond, and M. Z. Stamos (2006)**, "Life-Cycle Asset Allocation with Annuity Markets: Is Longevity Insurance a Good Deal?," Working Paper 146, Michigan Retirement Research Center, University of Michigan.
- Jagannathan, R. and N. R. Kocherlakota (1996)**, "Why Should Older People Invest Less in Stocks Than Younger People?," *Federal Reserve Bank of Minneapolis Quarterly Review*, 20, 11-23.
- Merton, R. C. (1969)**, "Lifetime Portfolio Selection Under Uncertainty: The Continuous-Time Case," *The Review of Economics and Statistics*, 51, 247-257.
- Samuelson, P. A. (1969)**, "Lifetime Portfolio Selection by Dynamic Stochastic Programming," *The Review of Economics and Statistics*, 51, 239-246.
- Viceira, L. M. (2007)**, "Life-Cycle Funds," Working Paper, NBER and CEPR.

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