Accumulating approach to the life-cycle pension model: practical advantages

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Abstract

In the present study, we make an effort to enhance the practical advantages of the life-cycle pension model. We observe that previous studies are based on a "switching" approach, that is, on the assumption that when a pension fund member reaches a certain age, his accumulated savings are fully switched to another fund with a lower risk profile; we suggest an "accumulating" approach, according to which, at the same age, the member's previously accumulated wealth continues to be invested in the same fund, while his new regular pension contributions start being directed to another (less risky) fund. We consider a hypothetical (average) Israeli employee, analyze two age-dependent life-cycle investment distributions of his pension savings, and perform a comparison between the two approaches to the life-cycle model by employing an estimation-based and a simulation-based technique. The results demonstrate that the "accumulating" approach provides: (i) higher estimated annualized real returns and real accumulated savings; (ii) significantly higher simulated mean and median values of real accumulated savings. Moreover, we document that, though the "accumulating" approach increases the standard deviation of total savings, it does not lead to critically low pension wealth levels even for relatively unfavorable sequences of financial assets' returns. Therefore, we conclude that the "accumulating" approach to the life-cycle model has a potential significantly to increase pension fund members' total accumulated wealth relatively to the common "switching" approach, without significantly increasing the members' risk.

Keywords: investment profitability and risk, life-cycle pension model, pension funds' investment policy, retirement savings

1 INTRODUCTION

The funding of pensions is an issue that has acquired particular relevance in recent years, due to the increased longevity of the population. The prime motivation behind instituting retirement savings plans is to generate adequate income for employees after retirement. The greatest risk for the participants, therefore, is that their retirement nest egg is insufficient to sustain a basic standard of living. The suitability of a retirement savings plan should then be assessed in terms of its ability to generate a minimum level of wealth to fund their basic needs.

A continuously increasing number of plan sponsors offer participants investment options that permit them to avoid investment decision-making. Among such innovations in the financial services marketplace are the life-cycle or target-date funds that have been promoted as a simple solution for retirement savers to be able to invest their savings with a hands-off approach. These funds are one of the most rapidly growing financial products of the last decade. They offer investors the opportunity to exploit time-varying investment rules, having a high allocation to risky assets (like stocks) when the participant is young and gradually switching to less volatile debt securities (like bonds and bills) as the retirement date approaches with the aim to reduce uncertainty in retirement outcomes (e.g., Viceira, 2008).

The basic idea of a life-cycle investment model is that at the beginning of the accumulation phase it is easier for members to bear riskier investments while for members with fewer years to retirement, security of investment is more important than high returns. Those members who have been in the pension system for a longer period have large savings, so that every fall in the value results in significant losses in the total amount of expected savings. Therefore, within the framework of a life-cycle investment model, for members with a shorter period of accumulation it is recommended that assets be invested in financial instruments with a higher expected risk (for example, equity), which should bring higher long term returns, while for members with a longer period of accumulation it is recommended that assets be invested in financial instruments with lower expected risks (for example, government bonds). Life-cycle funds have gained favor with retirement plan investors in recent years, since they are supposed to offer the best of both worlds – robust portfolio growth in the early years and preservation of the accumulated wealth as the investor comes closer to retirement. Moreover, once enrolled, there is no need for the investors to keep constant watch over their investment strategy. Life-cycle investment strategies are also said to reduce the volatility of wealth outcomes making them desirable to investors who seek a reliable estimate of final pension a few years before retirement (e.g., Blake et al., 2001). On the other hand, some researchers note that these benefits come at a substantial cost to the investor – giving up the significant upside potential of wealth accumulation offered by more aggressive strategies (Booth and Yakoubov, 2000; Byrne et al., 2007).

All the previous studies dealing with the life-cycle model are based on a "switching" principle, or approach, that is, on the assumption that when a pension fund member reaches a certain age, his accumulated savings are fully switched to another fund with a lower risk profile, or in other words, redistributed in new proportions between the major asset classes. This approach has the advantage of enhancing investment security for members who are close to retirement, but on the other hand, does not allow them to benefit from the profit potential that could be associated with investing the considerable amounts of savings accumulated in stocks during the early years of their working career.

In this study, we suggest and analyze an "accumulating" approach to the life-cycle model, according to which at the time when a pension fund member reaches the predetermined age for a change in the proportions of his investments, his previously accumulated wealth continues to be invested in the same (relatively risky) fund and remains there until his retirement, while his new regular contributions are invested in a less risky fund, that is, distributed between the major asset classes in more conservative proportions. In this way, by the retirement date, the pension fund member has his savings invested in a number of pension funds characterized by decreasing risk profiles.

In order to analyze this accumulating approach to pension savings' investments, we consider a hypothetical Israeli employee who works for 40 years earning an average inflation-indexed salary for his age group and contributes a mandatory proportion of his gross salary to a pension fund that charges management fees at the average rates accepted in Israel. We suggest two age-dependent investment distributions of the employee's pension savings that are in the spirit of the life-cycle model, and perform a comparison between the two approaches to the life-cycle model by employing two alternative techniques: (i) for both approaches, based on historical returns and return volatilities of major asset classes and correlations between their returns, estimate the expected real returns, return volatilities and the employee's total accumulated savings at retirement; and (ii) perform 10,000 simulations of monthly returns for all the asset classes over the employee's working career by randomly drawing respective (for the given asset class) observations from our sample of real historical returns, and as a bottom line of each simulation, obtain the employee's real accumulated savings, according to both approaches.

The results of the analysis demonstrate the advantages of the accumulating approach. First, according to the estimation-based technique, for both investment distributions, the expected annualized real returns and real accumulated savings based on the accumulating approach are appreciably higher than those produced by the switching approach, while the differences in the expected annualized standard deviations are relatively moderate, resulting in significantly higher Sharpe ratios for the accumulating approach. Second, according to the simulation-based technique, when the accumulating approach to the life-cycle model is employed, the mean and the median values of real accumulated savings are significantly higher than those obtained according to the switching approach. Moreover, though the accumulating approach increases the volatility of pension portfolio returns, the value at risk analysis of the accumulated retirement savings' distributions allows us to conclude that it does not lead to critically low pension wealth levels even if relatively unfavorable sequences of financial assets' returns take place over the employee's working career. Thus, the results produced by both techniques are consistent and allow us to conclude that the accumulating approach to the life-cycle model has a potential significantly to increase pension fund members' total accumulated wealth relatively to the common switching approach, without significantly increasing the members' risk.

The rest of the paper is structured as follows. Section 2 briefly reviews the literature dealing with the characteristics and the advantages of the life-cycle pension model. In section 3, we define the accumulating principle of the life-cycle model and formulate our research hypothesis. In section 4, we describe our research methodology. Section 5 provides the empirical tests and the results. Section 6 concludes and provides a brief discussion.

2 LITERATURE REVIEW

According to modern financial theory, a diversified investment portfolio is a key to an efficient risk-return trade-off in the long run. The long-term portfolio returns strongly depend on strategic asset allocation, i.e. on the risk exposure of the investment portfolio. This is especially true for retirement savings. Due to their long investment horizon, small differences in the average annual return will result in significant changes of the average financial wealth available at retirement.

The key intuition is that optimal portfolios for long-term investors may not be the same as for short-term investors, because of a different judgement of assets' riskiness, and because of the crucial role played by (non-tradable) human wealth in the investors' overall asset portfolio. The literature on strategic asset allocation provides numerous examples of cases where short-term asset allocation conflicts with longer term objectives, including selection of the risk-free asset, international portfolio diversification, and currency hedging strategies. The short-term volatility of a pension fund's return is not necessarily a good indicator of the pension risk in the case of a member who is at the beginning of his/her active working life and is still 30 years away from retirement. In general, no assurances can be given that competition in the short-term will result in long-term optimal asset allocation (Campbell and Viceira, 2002).

The modern financial theory has proposed that a suitable investment strategy for mitigating the risks in an individually funded system is to allocate assets in the portfolio according to the life-cycle profile of the individual, with exposure to risky assets decreasing over time toward a portfolio composed of less volatile assets at the point of retirement (e.g., Viceira, 2008). This investment strategy involves allocating a high proportion of one's assets to equities during the early period far away from the target date, and gradually shifting to more conservative assets, such as bonds and bills, as the target date draws nearer. It aims to minimize the risk associated with a sudden fall (e.g., because of a global or local financial crisis) in the value of the pension at the very moment when the person "needs" or has planned to start drawing a pension.

The basic idea is that at the beginning of entering the pension system it is easier for members to bear a risky investment because they have fewer accumulated funds, have more time to retirement and are more likely to reduce and compensate for any losses. On the other hand, at the end of the accumulation phase members prefer safer investments against returns, given the large amount of funds accumulated and the short term available to offset potential losses.

A vast body of research has tried to uncover reasons and to explain theoretically why an investor might choose to reduce his equity exposure as he ages. Gollier (2001), and Gollier and Zeckhauser (2002) derive the conditions under which the option to rebalance a portfolio in the future affects portfolio choice. Their results suggest that under specific assumptions about the structure of utility functions, the optimal portfolio share devoted to equity will decline with age. Campbell et al. (2001), and Campbell and Viceira (2002) develop numerical solutions to dynamic models that can be used to study optimal portfolio structure over the life-cycle if shocks to labor income follow specific stochastic processes and investors have power utility. Cocco et al. (2005) solve such a model in the presence of non-tradable labor income and borrowing constraints. They find that a life-cycle investment strategy that reduces the household's equity exposure as it ages may be optimal depending on the shape of the labor income profile. Kovacevic and Latkovic (2015) argue that the benefits of implementing life-cycle investments are clearly visible in the total expected amount of accumulated savings from the risk-return perspective. However, those benefits are partially diminished by the fact that the expected risk of a pension fund with the lowest risk profile is not substantially different from the expected risk of a pension fund with a medium risk profile, due to the lack of diversification of the former.

Fachinger and Mader (2007) suggest that decreasing equity exposure with age is the optimal strategy, regardless of the investor's risk preferences or particular life situation. They give two arguments to support this advice: (i) time diversification, and (ii) targeting for large liquidity needs in mid-life. Time diversification means that equity risk is decreased by long holding periods. Over longer periods of time, short-term stock market fluctuations are assumed to be less important. According to this argument, one can "diversify away" the riskiness of stocks simply by extending the holding period. Targeting for liquidity needs is based on the idea that when individuals save towards a specific goal, such as buying a house or paying college tuition fees, having higher equity exposure at the beginning of the savings period will lead to higher average returns. As the target date approaches, investors should decrease risk exposure to minimize the likelihood of missing their target.

Yet another argument supporting the idea of the life-cycle investments is based on savings plan members' risk aversion, which is expected to rise towards the end of the savings accumulation phase, when the pension payments phase begins. In such circumstances it is possible that the optimal structure of investment has a time-dependent dynamic. A number of studies show that the optimal investment strategy of a pension fund should be described with a life-cycle model that allows gradual adjustment of the allocation of a pension fund portfolio in time, i.e. continuous change in the ratio of investment in equity and bonds (e.g., Bagliano et al., 2009; Potocnjak and Vukorepa, 2012).

Gomes et al. (2008) compare popular default choices for defined contribution pension plans in terms of welfare costs. They compare the optimal path obtained through a utility model (unconstrained case) with a "stable value" fund (fully invested in bonds), two fixed portfolio strategies (with fixed proportions in equities of 50% and 60%, respectively) and a life-cycle investment strategy with a deterministic path that equals the optimal allocation in the unconstrained case for an individual with average risk aversion. They show that the life-cycle strategy is the one that results in the smallest welfare loss as compared to the unconstrained case, while at the other extreme, the case with no equity investment leads to significantly lower asset accumulation and consumption over the life cycle, particularly at retirement. Chai et al. (2009) also show that, in the optimal portfolio, equities are the preferred asset for young workers, with the optimal share of equities generally declining prior to retirement. In particular, they demonstrate that, when both hours of work and retirement ages are endogenous, the optimal share of equities still decreases with age, but equity fractions are considerably higher over the life cycle than reported in studies that do not allow endogenous retirement.

Viceira (2008) argues conceptually that an individual's total wealth is made up of his financial wealth and human capital, the latter element being measured as the present value of his future income from work. Therefore, changes in the relative importance of these two sources of wealth over the course of an individual's life justify the adoption of investment strategies in which the portfolio is gradually adjusted according to the worker's age (age-based strategies). At the beginning of the working life, it would be more appropriate to take risks in financial investment searching for higher returns. In this case, the human capital would act as an insurance mechanism since, assuming relatively constant labor income, this component may approximate to an implicit investment in bonds. During the approach to retirement age, the objective changes to one of safeguarding financial wealth by investing in safer instruments. In this line of argument, the design of investment strategies of this type also should take the heterogeneity of the members into account. For some workers, it would be more plausible to assume that labor income is uncertain and might therefore not be similar to an implicit holding in bonds.

There are many factors to consider in assessing optimal long-term investment from an individual investor's perspective (e.g., Larraín Rios, 2007). Mitchell and Turner (2010) discuss the importance of capturing human capital risk in models assessing pension performance. Other characteristics influencing optimal portfolios include habit formation, liquidity constraints and idiosyncratic labor income shocks (Bodie et al., 2009).

Antolin et al. (2010) argue that life-cycle strategies that maintain a constant exposure to equities during most of the accumulation period, switching swiftly to bonds in the last decade before retirement, produce better results and are easier to explain. They also observe that the length of the contribution period affects the ranking of the different investment strategies, with life-cycle strategies having a stronger positive impact the shorter the contribution period. Berstein et al. (2013) evaluate different life-cycle investment strategies for different types of workers. They calibrate a pension risk model for the Chilean economy, including measures of life-cycle income, human capital risk, investment and annuitization risks and document that affiliates can gain around 0.85 percentage points in terms of average replacement rates (ratio of the monthly pension payment to the worker's last wage before retirement) in return for an increase of 1 percentage point in risk, measured as standard deviation of replacement rates.

Bikker et al. (2012) examine the effect of pension plan participants' age distribution on the asset allocation of Dutch pension funds, and observe that the latter do take the average age of their participants into account. In line with the life-cycle model, a one-year higher average age of active participants leads to a significant and robust reduction in the strategic equity exposure by around 0.5 percentage point. Similarly, Inkmann and Shi (2015) document a negative relationship between the share of risky assets in Australian pension funds and the average fund members' age.

Horneff et al. (2008) compare different standardized payout strategies to show how people can optimize their retirement portfolios. They conclude that annuities are attractive as a stand-alone product when the retiree has sufficiently high risk aversion and lacks a bequest motive. Withdrawal plans dominate annuities for low/moderate risk preferences, because the retiree can gain by investing in the capital market. Chai et al. (2009) also introduce fixed and variable annuities in their model. They show that variable annuities generate higher levels of retirement income flows as compared to fixed annuities.

Governments are not comfortable giving recommendations on portfolio allocation. Although this reluctance is understandable, it is likely to result in individuals making suboptimal portfolio selections and ultimately receiving low levels of pensions in retirement. As documented by Campbell (2006), and Benartzi and Thaler (2007), when unable to make decisions, people tend to rely on simple heuristics that may end up being suboptimal.

3 RESEARCH HYPOTHESIS

Previous financial literature, as described in the previous section, theoretically and empirically demonstrates the advantages of the life-cycle approach to retirement savings' investments. However, all the studies dealing with the life-cycle model are based on the assumption that when a pension fund member reaches a certain age, his accumulated wealth is fully switched to another fund with a lower risk profile, that is, having a smaller proportion of assets invested in equity and a greater proportion of assets invested in bonds and bills. In other words, the whole amount of the member's pension savings is redistributed in new proportions between the major asset classes. This switching approach to the life-cycle model has a clear advantage of enhancing investment security for members who are close to retirement and definitely not willing to put their total, and considerable, wealth at risk. On the other hand, in order to get this enhanced security, the members have to sacrifice the significant profit potential associated with equity investments (e.g., Basu and Drew, 2009).

In this respect, we propose a kind of "golden mean" solution. We suggest an accumulating approach to the life-cycle model, in which at the time point when a pension fund member reaches the same (switching) age as above[1], his previously accumu-

[1] Obviously, the correct choice of a pension fund member's age when he switches between the funds with different risk profiles should be performed is a crucially important point in maximizing the member's final savings. Numerous researchers and pension planners have already analyzed and continue to analyze this matter, and there is probably no universal decision in this respect. However, the goal of our study is not to detect the ultimately correct age for the switch to take place, but rather to compare the performance of the standard "switching" approach to the life-cycle model with that of the "accumulating" approach we suggest, while keeping all the other factors, including the switching age, constant.

lated wealth *continues* to be invested in the same fund, while his *new* regular pension contributions start being directed to another fund with a lower risk profile. In other words, the wealth accumulated prior to the switching date remains in the same (more risky) fund until the member's retirement, while his new contributions are distributed between the major asset classes in more conservative proportions. In such a way, at the retirement date, the member actually has his savings invested in a number of pension funds distinguished by their risk profile. These funds may be managed by the same or by different investment companies and their total number is equal to the number of times during the member's working career when the switch between the funds takes place. It should be noted that the accumulating approach does not make the operation of pension funds more complicated or more costly, compared to the switching one, since from each investment company's point of view, the number of funds distinguished by their risk profile it operates does not change and remains equal to the number of times when the switch between the funds is performed during the fund member's working career. The only thing that is changed is that each member's savings are invested in several pension funds and not just one fund. For the same reason, potentially, if a member decides to transfer his savings to another investment company with another investment distribution, the accumulating approach does not cause any additional difficulties.

We hypothesize that employing this accumulating approach to the life-cycle model may significantly increase the pension fund members' total accumulated wealth relatively to the common switching approach, without significantly increasing the risk. We test this hypothesis below.

4 DATA DESCRIPTION AND METHODOLOGY

Our study is based on the mandatory pension insurance system in Israel. The system operates according to the defined contribution where an employee and his employer make monthly contributions to the employee's pension account, which is managed by a pension fund operated by one of the private investment companies. The employee has a right to choose the pension fund and to transfer his savings to another fund as many times during his working career as he wants. The total wealth accumulated in the account by the employee's retirement date determines the amount of the monthly pension payments he receives after retirement.

Realizing the practical advantages of the life-cycle pension model, on February 17, 2015, the Israel Ministry of Finance passed a resolution obliging all the pension funds in Israel to use programs consistent with the life-cycle model as default options for their members, starting on January 1, 2016. This important decision is supposed to change the previous state of affairs, when the employees' pension savings were distributed between asset classes in constant (and quite conservative) proportions, to ensure continuous adjustment of asset allocations towards retirement, and therefore higher expected returns, at least for the majority of Israeli employees. Yet, the resolution directs all pension funds to adopt the standard switching approach to the life-cycle model, that is, at the end of each age span, to transfer the whole amount of each employee's pension savings to another fund with a lower risk profile. In this context, the major goal of our study is to suggest, to test, and to discuss the accumulating approach to asset allocation, as a kind of "fine-tuning" for the life-cycle model.

For the purposes of our research, we analyze a hypothetical employee who is saving for retirement. The retirement age in Israel is 67 for men and 62 for women, so for the sake of convenience, we assume that the employee is a man, whose working career lasts 40 years, or 480 months (from the age of 27 till the age of 67). The employee earns an average gross salary for men workers in Israel. The employee's monthly salary changes with his age, according to the data reported by the Israel Central Bureau of Statistics for 2015, as shown in table 1.

Table 1
Average monthly gross salary for male workers in Israel, by age groups, according to the Israel Central Bureau of Statistics

Age group, years	Average monthly gross salary per worker, NIS
25-34	8,459 ± 436.3
35-44	12,950 ± 555.8
45-54	13,588 ± 781.6
55-64	13,904 ± 1,261.6
65+	9,777 ± 1,511.0

We assume that within each age group, the salary continuously grows by the same amount per year. For example, if for the age group 35-44, the reported monthly gross salary is 12,950±555.8 New Israeli Shekels (NIS)[2], then we assume that at the age of 35, the employee earns 12,950-555.8=12,394.2 NIS per month, while at the age of 44, he earns 12,590+555.8=13,145.8 NIS per month, the monthly salary y growing linearly during this 10-year period by 555.8/5=111.2 NIS per year. In addition, the employee's salary is inflation-indexed, that is, increases at the same rate as the Consumer Price Index (CPI)[3]. In other words, for each given age, the real (in terms of 2015) salary remains constant over time.

According to the regulation issued by the Israel Ministry of Finance, at the end of each month, the employee contributes 5.5% of his gross salary to his retirement savings account at a pension fund, while his employer contributes 6% of the employee's gross salary to the same account[4]. We assume that the pension fund charges management fees at the average rates that were employed in Israel in 2015, namely, 3.4% on the regular monthly contributions and 0.3% per year on the accumulated wealth.

[2] The official exchange rate for December 31, 2015 was 1 US Dollar=3.902 NIS.
[3] Average inflation rate in Israel over years 2000-2015 was 1.6036% per year (or 0.1327% per month).
[4] In practice, in addition to the 6% of the employee's gross salary, employers in Israel contribute 8.33% as a "compensation" component. But since the employee may withdraw this savings component after leaving a company, we choose not to consider this additional contribution in our analysis.

The employee's savings are invested by the pension fund in four major asset classes:

1) stocks,
2) corporate bonds,
3) government bonds,
4) pension-oriented (PO) bonds – a special category of Israeli government bonds sold only to pension funds and providing a fixed CPI-linked (real) annual yield of about 4.8%. Because of their relatively high, risk-free and inflation indexed yield, PO bonds are considered a privilege of the Israeli pension funds, and they are allowed to invest 30% of their total portfolio wealth in this category of bonds.

For our empirical analysis, we employ actual monthly returns for the four asset classes on the Tel Aviv Stock Exchange (TASE) over the years 2000-2015[5]. The benchmark indexes we use for the respective asset classes are as follows:

1) Stocks – we employ the TA-100 Index consisting of the 100 shares with the highest market capitalization. The composition of the index is updated twice a year.
2) Corporate bonds – we construct an equally-weighted portfolio of the two indexes:
   - Tel Bond-60 Index consisting of the 60 corporate bonds, fixed-interest and CPI-linked, with the highest market capitalization. As of December 31, 2015 the mean duration of the bonds making up the Index was 8.45 years. 48 out of 60 bonds had a high grade credit rating[6], while the rest of the 12 bonds had an upper medium grade credit rating.
   - Tel Bond-Shekel Index consisting of all corporate fixed-rate (unlinked) bonds. On December 31, 2015 the Index consisted of 84 bonds with a mean duration of 6.27 years. 42 out of 84 bonds had a high grade credit rating, 36 had an upper medium grade credit rating, and 6 had a lower medium grade credit rating.
3) Government bonds – we employ the Government Bonds General Index which includes all the government bonds traded on TASE. On December 31, 2015 the Index consisted of 13 CPI-linked and 18 unlinked bonds with mean duration of 7.18 years.

Table 2 comprises expected (average historical) annualized *real* returns and return volatilities (standard deviations) for the asset classes. It should be noted that real returns for stocks and corporate and government bonds are calculated by deducting actual monthly inflation rates from actual nominal monthly returns, while real annual return of 4.8% for PO bonds is provided by the definition of this asset class.

[5] This sampling period is chosen, as the official price and return data for all the asset classes are available on TASE website (www.tase.co.il) since 2000. Moreover, the use of these data may be justified by the fact that return and volatility rates we employ (reported in table 2) are comparable to (or perhaps slightly higher than) the respective rates usually reported for the developed markets over much longer periods (e.g., Dimson et al., 2014).

[6] According to Maalot credit rating agency estimates.

Table 2
Expected returns and return volatilities of major asset classes, annualized percent

Asset class	Expected real return	Expected standard deviation
Stocks	5.21	17.85
Corporate bonds	2.42	9.47
Government bonds	1.86	7.35
PO bonds	4.80	0.00

Table 3 reports the correlations between the returns of the four major asset classes. Since the returns of PO bonds are fixed and constant, they are uncorrelated with other asset classes' returns. The correlations between stock and bond returns are positive, but quite moderate, leaving some space for portfolio risk diversification.

Table 3
Correlations between the returns of major asset classes

Correlation coefficients	Stocks	Corporate bonds	Government bonds	PO bonds
Stocks	1	0.24	0.18	0
Corporate bonds	0.24	1	0.35	0
Government bonds	0.18	0.35	1	0
PO bonds	0	0	0	1

The employee's retirement savings are distributed between the asset classes in the spirit of the life-cycle model, that is, the proportion invested in stocks decreases with the employee's age, while the proportion invested in bonds, and especially in government bonds, simultaneously increases. We assume two alternative wealth distribution paths: the first one (MF investment distribution), presented in table 4, is based on age spans suggested by the Israel Ministry of Finance, while the second one (IC investment distribution), depicted in table 5, is consistent with the characteristics of a life-cycle pension fund proposed to the public since 2012 by one of the Israeli investment companies[7].

Table 4
Investment distribution between asset classes by employee's age suggested by the Israel Ministry of Finance (MF investment distribution), in %

Asset class	Proportion of total wealth invested, by employee's age		
	27-49	49-59	59-67
Stocks	40	25	0
Corporate bonds	20	25	30
Government bonds	10	20	40
PO bonds	30	30	30

[7] Note that in both investment distributions, the proportion of PO bonds remains similar (30%) for all age groups. As mentioned above, due to their relatively high, risk-free yield, these bonds are considered a privilege of the Israeli pension funds, so we may assume that the pension funds will hold them in the highest possible proportion, which is 30%.

Table 5

Investment distribution between asset classes by employee's age, suggested by one of the investment companies (IC investment distribution), in %

Asset class	Proportion of total wealth invested, by employee's age							
	27-32	32-37	37-42	42-47	47-52	52-57	57-62	62-67
Stocks	48	45	40	37	25	15	9	1
Corporate bonds	16	17	18	20	24	25	26	29
Government bonds	6	8	12	13	21	30	35	40
PO bonds	30	30	30	30	30	30	30	30

In order to test our research hypothesis, for both investment distributions, we calculate the employee's retirement savings based on both accumulating and switching approaches to the life-cycle model. We perform our empirical analysis employing two alternative techniques:

First, we estimate the expected real returns, return volatilities and total accumulated savings based on historical returns and return volatilities of the asset classes and the correlations between their returns. That is, for each given investment portfolio in each given period, we calculate[8]:

$$R_p = \sum_i w_i R_i \tag{1}$$

$$\sigma_p^2 = \sum_{i,j} w_i w_j \sigma_i \sigma_j p_{ij} \tag{2}$$

where w_i represents the share of an asset class in the portfolio, R_i and σ_i are its expected return and expected volatility, respectively, and p_{ij} is the expected correlation between the *i*th and *j*th asset classes, and furthermore, estimate expected returns and volatilities for both approaches to the life-cycle model and for both investment distributions. The total real accumulated savings are estimated by employing the expected (average historical) real returns, recalculated to monthly terms, on the series of the employee's monthly pension contributions over his whole working career. The results are shown in subsection 5.2.

Second, we simulate monthly returns for the four asset classes over the employee's 40-year working career by randomly drawing respective (for the given asset class) observations from our sample of historical returns. We perform 10,000 simulations employing actual real monthly returns for each asset class[9]. As a bottom line of each simulation, we obtain the employee's real accumulated savings. The results are analyzed in subsection 5.3.

[8] This approach is similar to the one employed by Kovacevic and Latkovic (2015).

[9] For stocks and corporate and government bonds, real monthly returns are obtained by deducting actual monthly inflation rates from actual nominal monthly returns, while for PO bonds, real monthly returns are fixed at the level of 4.8% per year (0.3915% per month).

5 RESULTS

5.1 ACCUMULATING VERSUS SWITCHING APPROACH: ASSET ALLOCATION BY THE EMPLOYEE'S AGE

First of all, we note that while with the traditional switching approach the asset allocation proportions for different age spans are straightforward and predefined at the beginning of the employee's working career, this is not the case for the accumulating approach, which is in the focus of our analysis. The older the employee, the greater the number of funds (distinguished by their risk levels) in which his savings are invested. The employee's pension contributions accumulated in relatively more risky funds continue to yield returns, which are not constant and may affect the proportions of asset classes in the employee's total investment portfolio.

Therefore, before proceeding to the analysis of the employee's accumulated savings, we take a closer look at the time trends of asset allocation proportions for both approaches. Tables 6 and 7 comprise proportions of the asset classes in the overall employee's investment portfolio, by his age (including the age of retirement), for MF and IC investment distributions, respectively.

Table 6

Age-dependent investment distribution between asset classes for the switching and accumulating approaches (MF investment distribution), in %

Panel A: Switching approach

Asset class	Proportion of total wealth invested at employee's age			
	27	**49**	**59**	**67**
Stocks	40	25	0	0
Corporate bonds	20	25	30	30
Government bonds	10	20	40	40
PO bonds	30	30	30	30

Panel B: Accumulating approach, based on return estimation

Asset class	Proportion of total wealth invested at employee's age			
	27	**49**	**59**	**67**
Stocks	40	40	37.8	30.5
Corporate bonds	20	20	21.1	23.3
Government bonds	10	10	11.1	16.2
PO bonds	30	30	30	30

Panel C: Accumulating approach, based on simulation

Asset class	Average (over 10,000 simulations) proportion of total wealth invested at employee's age			
	27	**49**	**59**	**67**
Stocks	40	40	37.7	30.4
Corporate bonds	20	20	21.3	23.4
Government bonds	10	10	11	16.2
PO bonds	30	30	30	30

Table 7
Age-dependent investment distribution between asset classes for the switching and accumulating approaches (IC investment distribution), in %

Panel A: Switching approach

Asset class	**Proportion of total wealth invested at employee's age**								
	27	**32**	**37**	**42**	**47**	**52**	**57**	**62**	**67**
Stocks	48	45	40	37	25	15	9	1	1
Corporate bonds	16	17	18	20	24	25	26	29	29
Government bonds	6	8	12	13	21	30	35	40	40
PO bonds	30	30	30	30	30	30	30	30	30

Panel B: Accumulating approach, based on return estimation

Asset class	**Proportion of total wealth invested at employee's age**								
	27	**32**	**37**	**42**	**47**	**52**	**57**	**62**	**67**
Stocks	48	48	47.2	45.6	44.2	40.1	35.3	28.4	26.1
Corporate bonds	16	16	16.3	16.8	17.2	19.2	21.6	24.7	25.5
Government bonds	6	6	6.5	7.6	8.6	10.7	13.1	16.9	18.4
PO bonds	30	30	30	30	30	30	30	30	30

Panel C: Accumulating approach, based on simulation

Asset class	**Average (over 10,000 simulations) proportion of total wealth invested at employee's age**								
	27	**32**	**37**	**42**	**47**	**52**	**57**	**62**	**67**
Stocks	48	48	47.3	45.7	44.4	40.4	35.8	29.2	26.5
Corporate bonds	16	16	16.3	16.8	17.1	19.1	21.4	24.4	25.4
Government bonds	6	6	6.4	7.5	8.5	10.5	12.8	16.4	18.1
PO bonds	30	30	30	30	30	30	30	30	30

A number of things may be noted in an analysis of the tables:

- Investment allocations for the switching approach in tables 6 and 7 are similar to those presented in tables 4 and 5, respectively. These proportions are defined by the Ministry of Finance and the investment company, respectively, and do not depend on the returns yielded by the assets in previous periods. At each switching age, the entire amount of the employee's savings is automatically transferred to another fund with a lower risk profile.
- At the beginning of the employee's working career, the allocation proportions according to the accumulating approach (for both techniques of asset return estimation) are similar to those according to the switching approach. The reason is that at the age of 27, the employee's savings are in any case invested only in one fund. Moreover, at the beginning of the second age span (49 for MF and 32 for IC investment distribution), the allocation proportions with the accumulating approach remain unchanged, since at this age, the entire amount of previously accumulated savings continues to be invested in the first (the most risky) fund.
- For the accumulating approach, the allocation proportions based on return estimation are quite close to the average allocation proportions based on simulation, which may be explained by the fact that the average expected

returns employed in the estimation are based on the same historical sample of returns used for the simulation, as well as by the fact that PO bonds yielding fixed real returns make up a considerable (and constant) part of all the investment portfolios we are dealing with. The reason for the slight differences in the proportions is that the assets' historical returns are not exactly normally distributed.

- With the accumulating approach (for both techniques of asset return estimation), the proportions of the more risky asset (stocks) decrease and the proportions of the less risky assets (corporate and government bonds) increase with the employee's age. Yet, compared to the switching approach, the proportions of stocks held in accordance with the accumulating approach are higher, the differences increasing with the employee's age. For both approaches, the proportion of PO bonds remains constant (30%) throughout the employee's working career, since, notwithstanding the risk profile, all the age-dependent funds hold the maximal possible proportion of this privileged asset.
- With the accumulating approach (for both investment distributions and for both techniques of asset return estimation), asset allocations continuously change with the employee's age, and at age of 67 significantly differ from those set at age of 27, though the respective differences are smaller compared to those obtained with the switching approach. Therefore, both approaches preserve the major advantage of the life-cycle model over a "non-life-cycle" model (keeping the asset proportions constant for all ages), namely, the higher investment security for the employees who are close to retirement.[10]

5.2 ACCUMULATING VERSUS SWITCHING APPROACH: RETURNS AND SAVINGS ESTIMATION

As detailed in section 4, we perform a comparison between the two approaches to the life-cycle model employing two alternative techniques. First, based on historical returns, return volatilities and correlations of the asset classes, by equations (1) and (2), respectively, we estimate the expected real returns and return volatilities over the accumulation period. Furthermore, we estimate total real accumulated savings by applying the expected (average historical) real returns, recalculated to monthly terms, on the series of the employee's monthly pension contributions over his whole working career.

Tables 8 and 9 depict the estimated measures obtained according to both approaches, for MF and IC investment distributions, respectively.

[10] Though the goal of our study is not to advocate the life-cycle model in general, but rather to compare two potential approaches to the model, we have repeated our empirical analysis, using both investment distributions and both techniques of asset return estimation, for a pension fund that keeps all asset allocations constant throughout the employee's working career. The results (available upon request from the authors) demonstrate that employing this "non-life-cycle" model of investment distribution leads to significantly higher standard deviations of returns compared to those reported in tables 8 to 11 for the two approaches to the life-cycle model (for example, with MF investment distribution we obtain an estimated standard deviation of 9.29% and a simulated standard deviation of 1,312,581 NIS), the differences in the expected returns being much less dramatic.

Table 8

Estimated expected real returns, return volatilities and employee's total accumulated savings (MF investment distribution)

Asset allocation approach	Expected real return, annualized %	Expected standard deviation, annualized %	Expected real accumulated savings, NIS
Accumulating	4.18	5.76	1,129,749
Switching	3.82	5.43	1,018,440

Table 9

Estimated expected real returns, return volatilities and employee's total accumulated savings (IC investment distribution)

Asset allocation approach	Expected real return, annualized %	Expected standard deviation, annualized %	Expected real accumulated savings, NIS
Accumulating	4.16	5.61	1,112,605
Switching	3.79	5.32	987,805

First, as hypothesized, the expected annualized real returns based on the accumulating approach make up 4.18% (4.16%) with MF (IC) investment distribution, compared to 3.82% (3.79%) produced if the switching approach is adopted. These real expected returns transform to the employee's total real accumulated savings of 1,129,749 (1,112,605) NIS for the accumulating approach, compared to 1,018,440 (987,805) NIS for the switching approach. It is worth noting that if we assume a life annuity rate of 200[11], then the employee's replacement rate[12] according to the accumulating approach is expected to be 0.500 (0.493), which is quite an improvement relative to 0.451 (0.438) made up according to the switching approach.

Importantly, expected annualized standard deviations make up 5.76% (5.61%) for the accumulating approach and 5.43% (5.32%) for the switching approach. If we assume that the Bank of Israel annualized real rate of interest is 2.16%[13], then we obtain the Sharpe ratio of 0.36 (0.35) for the accumulating and 0.30 (0.30) for the switching approach, making up a difference of 20% (16.7%) between the risk-adjusted performance measures of the two approaches. Therefore, we may argue that though due to the higher proportions of the risky asset in the investment portfolio, the estimated volatility is higher if one decides to employ the accumulating approach, the differences in the expected standard deviations do not look dramatic. The reasons for these slight differences are the relatively moderate and gradually increasing differences between the two approaches in what concerns

[11] At the moment, the life annuity rates in Israel are about 180-190, but we may expect them to grow, at least moderately, following the life expectancy growth.
[12] Defined as a ratio of a pension fund's member monthly pension payment to his expected last salary.
[13] Over our sampling period of 2000 through 2015, the Bank of Israel average annualized nominal rate of interest was 3.7957%, while average annualized inflation rate in Israel was 1.6036%.

the proportions in which risky assets are held, as well as the constant (and equal) proportions in which PO bonds are held in both approaches. One more thing to note is that if we take a look at the portfolios' composition at investor age of 67, then, as clearly arises from tables 6 and 7, the portfolio constructed following the accumulating approach is more risky than that built following the switching approach. Yet, the major goal of our study is to look for potential ways of maximizing the total amount of the employee's savings *at* retirement, or in other words, ways of maximizing the risk-adjusted expected returns on his pension savings portfolio over his working career, and the accumulating approach is the one that allows us to make some progress in this direction. In order to ensure the employee's pension payments *after* retirement, certain steps may be taken for decreasing his retirement portfolio risk. Maximizing pension portfolio returns after retirement while keeping the risk level reasonably low is an interesting topic for further research.

5.3 ACCUMULATING VERSUS SWITCHING APPROACH: SIMULATION RESULTS

Our second technique of comparison between the two approaches to the life-cycle model is based on a simulation. As explained in section 4, for the employee's 40-year (480-month) working career, we perform 10,000 monthly return simulations by randomly drawing observations from our sample of historical real monthly returns[14]. These simulated returns determine the performance of the employee's pension investment portfolio, so that at the end of each simulation, we obtain the total amount of his real accumulated savings.

Tables 10 and 11 report, for MF and IC investment distributions, respectively, the mean, median and standard deviation of the employee's real accumulated savings over the sample of 10,000 asset return sequence simulations, employing both accumulating and switching approaches to asset allocation. In addition, the tables present the mean and median differences between the wealth accumulated according to each of the two approaches, and the t-statistics for the respective differences.

Table 10

Simulated employee's real accumulated savings (MF investment distribution)

Statistic	Accumulating approach	Switching approach	Difference (t-statistic)
Mean, NIS	1,142,714	1,029,120	***113,594 (23.15)
Median[a], NIS	1,113,358	1,007,567	***105,791 (22.36)
Standard deviation, NIS	914,124	847,963	

[a] We employ Wilcoxon/Mann-Whitney test for median equality.

*Asterisks denote two-tailed p-values: ***p < 0.001.*

[14] Alternatively, in order to preserve correlations between asset classes, we have performed 10,000 monthly return simulations by randomly drawing months, rather than individual observations, from our working sample, and subsequently employing real monthly return rates contemporaneously registered for all the asset classes during the respective months. The results, available upon request from the authors, are qualitatively similar to those reported and discussed in subsections 5.3 and 5.4.

Table 11
Simulated employee's real accumulated savings (IC investment distribution)

Statistic	Accumulating approach	Switching approach	Difference (t-statistic)
Mean, NIS	1,114,581	997,792	***116,789 (24.81)
Median[a], NIS	1,093,267	984,187	***109,080 (24.12)
Standard deviation, NIS	905,358	846,837	

[a] *We employ Wilcoxon/Mann-Whitney test for median equality.*
*Asterisks denote two-tailed p-values: ***$p < 0.001$.*

The results in both tables corroborate our research hypothesis. As expected, when the accumulating approach to the life-cycle model is employed, suggesting that higher proportions of wealth are invested in stocks, the standard deviations of the total amounts of savings are higher, but on the other hand, and in a more pronounced way, for both investment distributions, the mean and the median values of real accumulated savings are also higher than those obtained according to the switching approach. These mean (median) differences make up 113,594 (105,791) NIS, according to MF investment distribution, and 116,789 (109,080) NIS, according to IC investment distribution, all the differences being highly statistically significant.

Thus, the results based on the simulation are consistent with those based on return estimation in what concerns the superiority of the accumulating approach. Moreover, the simulation technique allows us to establish that the differences in the accumulated savings between the two approaches are statistically significant, which implies that the relative advantage of the accumulating approach in terms of returns "outperforms" its relative disadvantage in terms of risk. Another observation arising from the simulation results is that the differences between the two approaches are slightly higher for IC investment distribution, suggesting that the relative advantages of the accumulating approach are more pronounced the more times asset redistribution takes places during the employee's career.

5.4 ACCUMULATING VERSUS SWITCHING APPROACH: THE EFFECT OF RISK

In previous subsections, we have shown that employing the accumulating approach to asset allocation leads to higher expected values and significantly higher simulated mean and median values of the accumulated retirement savings. Yet another result is that the standard deviation of these values increases as well. We have already established that the increase in the volatility is quite moderate, but because of the major importance of the risk component in any analysis concerned with pension savings, in this subsection we take a closer look at the downside potential of the employee's accumulated savings. Adopting the approach used by Scheuenstuhl et al. (2010), we calculate the following measures that deal with the issue of risk from different points of view:

1) Value at risk of the accumulated savings distribution on a 95% confidence level ($VaR_{5\%}$): this risk-measure describes the result that could happen under very unfavorable circumstances. The measure represents the highest value of the accumulated savings achieved by the 500 (out of 10,000) worst scenarios. Thus, in 95% of the scenarios, the values of the accumulated savings are higher than this risk level. This risk-measure is directly computed by identifying the 5% percentile value of the empirical accumulated savings distribution, that is:

$$VaR_{5\%} = \inf\{x, P(AccSav < x) \geq 5\%\} \tag{3}$$

where: $AccSav$ stands for the value of real accumulated savings at retirement.

It is worth noting that since we seek to maximize the value of the accumulated savings, with this specification of the value at risk, the higher the VaR the lower the risk.

2) Conditional value at risk of the accumulated savings distribution on a 95% confidence level ($CVaR_{5\%}$): this risk-measure provides the expected value of the accumulated savings in the 5% worst cases, that is:

$$CVaR_{5\%} = E[AccSav \mid AccSav < VaR_{5\%}] \tag{4}$$

Once again, since our goal is to maximize the value of the accumulated savings, we may note that a high $CVaR_{5\%}$ is better than a lower $CVaR_{5\%}$. Obviously, based on the definitions, $CVaR_{5\%} \leq VaR_{5\%}$ holds.

Tables 12 and 13 report these risk measures for MF and IC investment distributions, respectively.

Table 12
Simulated employee's real accumulated savings risk measures (MF investment distribution)

Statistic	Accumulating approach	Switching approach
$VaR_{5\%}$, NIS	879,391	876,832
$CVaR_{5\%}$, NIS	848,257	855,671

Table 13
Simulated employee's real accumulated savings risk measures (IC investment distribution)

Statistic	Accumulating approach	Switching approach
$VaR_{5\%}$, NIS	877,992	875,112
$CVaR_{5\%}$, NIS	844,374	853,648

The tables demonstrate that for both investment distributions, the values of $VaR_{5\%}$ are slightly higher if the accumulating approach is adopted. In fact, with MF (IC) investment distribution, the accumulated savings values produced by the accumulating approach are higher for 95.87% (96.02%) of the simulations. This represents an important argument in favor of the accumulating approach, since it appears that though this approach increases the return volatility, investment scenarios resulting in savings values that are lower than those obtained according to the switching approach are relatively rare. Moreover, although, as might be expected, the values of $CVaR_{5\%}$ are lower if the accumulating approach is adopted, indicating that the latter performs worse in extremely unfavorable investment scenarios, the differences in the values of $CVaR_{5\%}$ between the two approaches are relatively small, suggesting that even in extremely unfavorable scenarios the accumulating approach, based on the asset allocations employed in our study, is not expected to result in a financial disaster for the employee.

Overall, the results presented in this subsection reinforce our conclusion that the disadvantage of the higher volatility of total savings does not detract from the major advantage of the accumulating approach, because of the significantly higher mean and median savings amounts it provides.

6 CONCLUSION AND DISCUSSION

In the present study, we analyze the life-cycle pension model, which is based on the idea that the exposure of pension fund members' portfolios to risky assets should be gradually decreased with the members' ages. We make an effort to enhance the model's practical advantages and suggest, instead of the standard switching approach, which is based on the assumption that when a pension fund member reaches certain age, his accumulated wealth is fully switched to another fund with a lower risk profile, the employment of an accumulating approach, according to which at the same time point as above, the member's previously accumulated wealth continues to be invested in the same fund, and only his new regular pension contributions start being directed to a less risky fund.

To empirically test the suggested approach, we consider a hypothetical (average) Israeli employee who works for 40 years earning an average inflation-indexed salary for his age group and contributes a mandatory proportion of his gross salary to a pension fund. We analyze two age-dependent life-cycle investment distributions of the employee's pension savings, and perform a comparison between the two approaches to the life-cycle model by employing an estimation-based and a simulation-based technique.

The results produced by the two techniques are consistent and demonstrate the advantages of the suggested accumulating approach. First, the expected annualized real returns and real accumulated savings based on the estimation are considerably higher if one adopts the accumulating instead of the switching approach, while the differences in the expected volatility levels between the two approaches are relatively moderate, resulting in significantly higher Sharpe ratios for the accumulating approach.

Furthermore, simulation results prove that when the accumulating approach to the life-cycle model is employed, the mean and the median values of real accumulated savings are significantly higher than those obtained according to the switching approach. Moreover, the value at risk analysis of the accumulated retirement savings' distributions allows us to conclude that, though the accumulating approach increases the standard deviation of total savings, it does not lead to critically low pension wealth levels even for relatively unfavorable sequences of financial assets' returns.

Generally speaking, the goal of this study was, obviously, not to criticize the life-cycle pension model, which has definitely proved its viability and has the clear advantage of enhancing investment security for the pension fund members who are close to retirement and definitely not willing to put their total, and considerable, wealth at risk. The goal was rather to minimize the model's relative disadvantage, which is that in order to benefit from the enhanced security of their pension savings, the members have to sacrifice a significant profit potential associated with equity investments. The accumulating approach we suggest allows a significant increase pension portfolios' returns, without a concomitantly significant increase in their risk, and therefore, we believe that the findings of our study may serve as a useful practical recommendation for both pension fund managers and policy makers dealing with pension systems.

After all, the major goal of any economist is to contribute, as far as possible, to the well-being of their country's citizens and to the efficiency of the world economy as a whole. In this respect, we hope that the results of our study have a potential of making at least a modest contribution. If public sector officials adopt the accumulating approach we suggest as a default approach to the life-cycle pension model[15], it may bring a number of important (and positive) consequences. The first and the most straightforward effect directly arises from the findings of our study, demonstrating that, all other things being equal, an employee whose pension savings are invested according to the accumulating approach is expected to be able to take advantage of higher pension payments after retirement. The higher replacement rate he is expected to enjoy may help him to go more smoothly through the transition from the category of employee to the category of pensioner.

Yet, there are also important potential indirect effects of adopting the accumulating approach. Since, as we have seen, it suggests investing a greater overall proportion of pension savings in stocks, adopting it may decrease the cost of capital for public companies and therefore enhance productive investments and create new working places. Moreover, higher pension payments may increase consumption and once again, stimulate the economy as a whole. Finally, adopting this approach may help to decrease the number of people whose retirement savings are not sufficient to ensure a deserved quality of life after retirement and who therefore stand in need of income transfers from working people. This result may be of serious help to the economic policy makers who are now heavily concerned with the problem of forced wealth redistribution when facing the reality of a continuously increasing life expectancy without increasing the retirement age.

[15] We have already taken a number of practical steps in order to promote our recommendations to the Israeli pension system.

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