**A Guaranteed-Return Structured Product   
as an Investment Risk Hedging Instrument in Pension Savings Plans**

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Abstract

In this study, we propose the integration of a novel structured product among the basket of financial products sold to pension fund members in order to deliver a guaranteed return on members’ pension savings while hedging members’ exposure to the risk intrinsic to capital market investment. The structured product we have developed is based on continual trading in risk-free government paper and the purchase of options on a benchmark equity market index that guarantees a minimum return on pension savings and, concurrently, a partial percentage of exposure to the expected positive return on the benchmark index. The study tests the investment strategy of the structured product against a balanced investment portfolio by performing Monte Carlo simulations on three different structured products, measuring their performance across a wide variety of capital market return and risk scenarios. The results of the study show that, under certain market conditions, the structured product can guarantee a return on the pension savings portfolio and can offer a higher portfolio return at a lower investment risk than would the balanced investment portfolio, making it an excellent investment alternative for pension fund members. Accordingly, marketing this product to pension fund members has the potential to revolutionize Israel’s pension industry.

1. Introduction

The importance of pension research has increased considerably in recent years following substantial changes in most developed countries’ pension industries. Academic work by Gustman and Steinmeier (1992), Clark and Hebb (2004), Thomas, Spataro, and Mathew (2014), and others describe a growing trend of shifting from traditional pension schemes of the defined benefit (DB) type, in which members’ entitlements (old-age insurance, pension, and survivor benefits) are defined from the outset by the employer and do not change over time, to defined contribution (DC) pension plans, in which members’ entitlements vary commensurate with the development of monetary accrual in the member’s pension fund account (Spivak and Yosef, 2005).[[1]](#footnote-1) Historically, DB pension plans have been more popular than DC plans in most developed countries, but a gradual transition from DB- to DC-type pension plans has taken place over the years in most of these countries (Thomas et al., 2004).[[2]](#footnote-2) An OECD report (2013) reveals growing use of DC-type programs in seven of seventeen countries between 2001 and 2012.[[3]](#footnote-3) Today, total assets managed in DC programs exceed those managed in DB plans in most OECD member states.[[4]](#footnote-4)

The academic literature offers several reasons for the changeover from DB to DC pensions, including: (1) the globalization trend in industry, contributing to a dramatic increase in the mobility of local labor forces and, in turn, a preference for DC pension arrangements, which are more easily transferrable among employers (Broadbent, Palumbo and Woodman, 2006; Thomas et al., 2014; Fang, 2016); (2) a steep increase in financial pressure on private firms and public entities that pay DB pensions as a result of increased pension payouts due to longer life expectancy (Bodie and Crane, 1999; Raugh, 2005; Whitehouse, 2007); and (3) regulatory changes (e.g., in taxation and legislation) affecting DB programs that provided incentives to move to DC plans.[[5]](#footnote-5)

Switching to a DC pension plan is advantageous to workers in several ways, such as making it possible to adjust the investment portfolio to workers’ objective risk and personal situation, and allowing pension savings to be transferred when workers switch employers (Bodie et al., 1988). However, the transition to DC pensions has the major drawback of raising the level of exposure of pension savings to several possible risks. Studies such as those of Benartzi and Thaler (2001) and Lachance, Mitchell, and Smetters (2003) show that switching to a DC pension plan amplifies the risk and raises the costs of pension savings to the worker by making pension savings contingent mainly on the quality of the managing entity’s investments, in which neither return nor safety is guaranteed, thereby directly exposing the pension fund member to the risk of volatility in the financial markets. This risk grows as workers approach retirement age because a steep decrease in the return on the investment, as happened in the 2008 subprime crisis, may reduce workers’ pension payments significantly. Additional risks to workers are exposure to an increase in life expectancy and future regulatory changes that may prolong workers’ pension contributions (Broadbent et al., 2006).[[6]](#footnote-6)

The Israeli case exemplifies the increase in risk to the pension fund member as a result of switching to a DC program due to legislative changes and reforms in the pension industry, as specified at length by Spivak and Yosef (2005) and Afik, Feinstein, and Galil (2014). In March 1995, the Israeli government carried out a comprehensive reform in the pension system, its main features including: (1) prohibiting veteran pension funds from accepting new members due to their large deficits; and (2) establishing new pension funds for the newly insured that would operate under the DC principle.[[7]](#footnote-7) Pursuant to this reform, in May 2003, the Knesset (the Israeli parliament) approved another significant pension reform, essentially a major liberalization of the terms of new pension funds’ investments in the capital market. This triggered a powerful increase in these funds’ investments in the capital market—leading to, inter alia, a steep increase in the exposure of pension savings to the risks inherent in capital markets.[[8]](#footnote-8) Subsequently, in 2005, a comprehensive capital market reform (the Bachar Commission reform) went into effect, lowering bank concentration in managing the public’s savings.[[9]](#footnote-9) In its essence, the reform required the banks to sell off the provident and mutual funds they controlled to private entities in order to reduce their concentration in the credit industry (Bank of Israel, 2004). This triggered a major increase in the number of private investment entities, resulting in heightened competition for the management of the public’s savings and an increase in business financing via corporate paper, which have become a popular component of investment among institutional players in Israel.[[10]](#footnote-10) Even so, the subprime crisis of 2008 considerably reduced the value of institutional holdings in Israel, much to the detriment of the savings of members of DC pension funds. OECD data (OECD, 2016) show that in 2008, the average portfolio of Israel’s pension funds lost more than 16% relative to the starting value that year as a result of the global subprime crisis.[[11]](#footnote-11)

In the aftermath of the financial crisis and the upturn in risk to pension savers in Israel, the government introduced several new regulations and regulatory changes in order to protect members’ pension savings. In 2009, the Israel Ministry of Finance established the Hodek Commission for the management and mitigation of credit risks to institutional players and in 2010, pursuant to the commission’s work, the government promulgated regulatory legislation that limited and systematized these players’ activities in investing in corporate paper. In subsequent years, the Ministry of Finance examined the stability of pension savings, particularly of pension recipients and members verging on retirement, for the purpose of applying the “Chilean model” roadmap, based on adjusting the extent of exposure to risk to the age of members.[[12]](#footnote-12) In early 2016, the Ministry of Finance introduced a comprehensive reform called “the *hakham* model” (an acronym for “adjusted monetary saving”), which related to a method of allocating earmarked bonds that varies commensurate with members’ age, which reduces the risk exposure for a member before retirement, but significantly increases it for young members, who constitute the majority of savers in Israel.[[13]](#footnote-13)

The trend of involvement of pension institutions in the capital market can also be observed in most developed countries. Recent data point to an average increase of 4.3% in the share of these institutions’ investments between 2010 and 2015, which totalled $25 trillion in 2015 (OECD, 2016). The pension institutions’ performance after the subprime crisis (between 2010 and 2015) shows a real average positive yield in all OECD countries except Turkey (-2%). This return, however, is typified by a wide variability, reflected in high negative yields in some years, as in Greece in 2010 (-7.8%), Estonia and Poland in 2011 (-8% and -9.1%, respectively), Denmark and Turkey in 2013 (-4.5% and -7.6%, respectively), and more. The large variance of returns among years and among OECD countries is likely attributable to a high percentage of pension investment exposure to equity and bond markets. Updated data for 2015 show average holdings of equities and bonds exceeding 75% of the worth of pension institutions’ investment portfolios in these countries.[[14]](#footnote-14)

As a result of the increase in exposure of pension fund members’ money to the capital market, which is expected to continue as most developed countries adopt policies that favor more involvement of institutional players in capital markets, recent years have seen a strong upturn in demand for insurance products and supplemental financial products that deliver a guaranteed return on pension savings in many developed countries (OECD, 2016). Studies such as those of Yosef (2006) and Hens and Rieger (2008) show that products assuring investors the highest return on investment in risk-free interest are more popular than investments in a basket of risk assets (such as equities, bonds, and indices), thus guaranteeing savers a minimal return on their investment. Similarly, studies such as those of Dichtl and Drobetz (2011), Knoller (2016), and others document a strong increase in the use of these products by companies and individuals in order to hedge the risk of investing in the capital market, particularly after the subprime crisis.

Pursuant to the trend observed, the purpose of this study is to present a new instrument that can serve as a safety net for these workers’ pension savings by hedging the risk inherent in investments in the capital market. Accordingly, the main research question is: **Under what conditions is it possible to ensure that pension savings of workers nearing retirement are protected? And at what cost to the worker?** Pursuant to the goals of this study, we propose the development of a financial product that will protect pension savings against possible value impairment and, thereby, minimize exposure to capital market volatility. This product combines investment in purchase options on an underlying index that tracks the equity market (such as the CAC40, DAX, the S&P 500, and so on) that, in their essence, ensure protection against a decline in the benchmark index (and, with it, the value of the investment), such as to insure its purchasers against a decline in the value of their pension savings. The advantage of combining options and a hedging strategy in the financial product is that such options are available for purchase on stock exchanges around the world, making it possible to continually insure the investment. The current study examines several possibilities of hedging against capital market volatility by means of this financial product and demonstrates how they are priced.

The study continues as follows. In Section 2, we describe the financial product developed. In Section 3, we present the simulation method that we applied in order to price this product. In Section 4, we show the results of the simulation. Section 5 discusses the main findings and Section 6 summarizes the work done in the study and discusses the main conclusions.

1. The Structured Product

The structured product that we present is a financial product meant to be marketed and sold by pension institutions to members whose savings they manage, allowing members to increase the potential return on their pension saving portfolio by investing in the capital market without being exposed to market volatility risk. The structured product allows the institutional player to insure members against serious impairment of the value of the investment in the capital market, in return for a fee charged against the member’s savings, without involving the pension institution in risk that could threaten its stability. Accordingly, the structured product incentivizes both the pension institution, which is interested in obtaining a risk-free profit, and the members, who want to insure their pension savings against declines in the capital market as well as to increase the likelihood of a profit.

Our structured product is defined as a fixed-term contract between a pension institution (the issuer) and a pension saver (the investor) that protects the pension portfolio against a decline in its value beneath a floor that is set forth in the contract and determined in accordance with the investor’s wishes. In return, it provides the investor with part of the return on a benchmark index that typifies the equity market insofar as this index attains a positive return during the term of the contract. Under the conditions of the contract, the investor deposits the total investment with the pension institution for the entire period up to the expiration date of the contract, and in return, the investor receives insurance against a decline in the value of the investment beneath a floor value, defined according to the beginning value of the principal plus a minimum guaranteed return. The guaranteed rate of return that the customer can receive is the difference between the risk-free interest rate (attained by an investor in tradable government paper) and a percentage that the pension institution charges the investor in order to cover expenses, fees, and issuer’s profit.

The following example demonstrates the essence of the contract offered by the structured product. Assume that the risk-free interest rate is 4%, the issuer’s markup is 3% (operating expenses, hedging, and profit), and the rate of participation in the benchmark index is 40%. If the benchmark index falls during the term of the investment, the investor will receive the principal plus a 1% guaranteed return (the difference between the risk-free interest rate and the percent that the issuer demands). If the index rises by 20%, the investor will receive, in addition to the guaranteed floor, an additional 8% return on the principal (40% of the increase in the index), for a total return of 9% on the investment. Accordingly, the structured product offers the potential investor a safe investment that may generate a return that is higher than the current risk-free interest rate.

The structured product allows the possibility of exposure to the capital market by means of an investment strategy that combines buying tradable government paper with buying purchase options on the benchmark index in a proportion that limits the risk to the pension institution issuing the structured product to expenses exceeding the floor value specified in the contract (due to an increase in market value).[[15]](#footnote-15) In this manner, the structured product provides the pension saver with a component of insurance without involving the pension institution in the risk, in contrast to managing a defined benefit investment portfolio for the member, which exposes the pension institution to high risk of market volatility.

The portion of the potential positive return on the index that can be paid to the investor (measured from point-of-purchase of the product up to expiration of the purchase option) is derived from the changing price of the option in the tradables market, which determines the quantity of purchase options that the pension institution should acquire (in accordance with market data). The model that we present makes it possible to easily calculate the share of the index return that the investor receives and the cost of hedging to the investor under any possible scenario.

To clarify, we note that the portion of the positive return of the benchmark index that can be paid to the customer, and the cost to the investor, are determined in accordance with the customer’s risk preference, which is reflected in the floor value that the investor requires, the duration of the contract, and the market conditions of risk-free interest and market volatility. Accordingly, a risk-averse investor who is interested in a high guaranteed return that approximates risk-free interest in the market will receive a smaller share of the positive return of the index (if any) and will pay the pension institution less than would an investor who wishes to lower the assured floor payment and increase the percentage of exposure to the market yield. In the same context, both investors will have to settle for a smaller share of the potential return on the benchmark index at times of acute volatility in the capital market (which makes the option considerably more expensive) or, alternatively, will have to pay the pension institution more for its maintaining the percent of exposure to the return on the benchmark index.

2.1 The Model

The mathematical model of the structured product describes the relation between a parameter that represents, indirectly, the investor’s risk preference (measured by the level of minimum guaranteed return that the investor demands) and parameters that relate to the market data, on the one hand, and the characteristics of the structured product that determine the potential return on the investor’s pension savings portfolio and the cost to the investor of hedging the portfolio. The cost to the investor is measured relative to the alternative of investing in risk-free government paper, for which the investor must pay the issuer a certain percentage of the alternative risk-free interest that the investor would earn for participating in some of the positive return on the investment in the equity market, the expectation of which exceeds the risk-free interest rate. Therefore, the cost to the investor is set at the difference between the risk-free interest rate and the level of the guaranteed return that the investor demands, in accordance with:

where is the cost to the investor of raising the percentage that can be obtained from an increase in the index, the value of which is discounted to the day of the investment, is the minimum guaranteed return to the investor at the end of the contract, is the time that lapses until the structured product specified in the contract expires, and is the risk-free interest rate, with continuous compound interest, calculated on the basis of data on government paper at the beginning of the contract. Equation (1) indirectly describes the total cost (including the pension institution’s operating expenses and profit) of the structured product to the investor as a function of the investor’s risk aversion, measured in terms of the level of the guaranteed return the investor demands.

To substantiate this, a risk-loving investor who wishes to receive a high percentage of exposure to the capital market in return for partial hedging of the investment portfolio will pay more than would a risk-adverse investor who is willing to settle for a smaller exposure to the capital market (in return for a higher guaranteed return on the investment portfolio).

Under these conditions, the structured product guarantees the member the floor value of the beginning principal plus the minimum guaranteed return to the investor () or a percentage of the potential positive yield of the benchmark index that is observed, whichever is higher. Therefore the value of the worker’s pension portfolio at point of expiration is defined by:

where is the value of the member’s pension portfolio at the time the contract is signed (Time 0), is the observed benchmark index return from the time the contract is signed to the time it expires, measured on the basis of the value of the index (*I*) at the end of the period compared to its initial value according to י, and *Z* is the share (in percent) of the benchmark index return that is paid to the investor at the end of the contract.

The level of the benchmark index return and 0 in Equation (2), whichever is higher, is identical to the payments upon the expiration of a European purchase option written on underlying asset at exercise price 1. Therefore, the current value of the expression may be calculated as the value of the option (in the money) at the time the contract is signed, e.g., by using the Black and Scholes (1973) formula, in accordance with:

(3)

where *q* is the dividend return of the benchmark index and is the normal standard distribution, whereas *d1* and *d2* are characteristics of the purchase option as determined in accordance with the time the contract expires, *T*, risk-free interest rate *r*, dividend return *q*, and benchmark index volatility , according to:

(4)

The amount of money invested in risk-free government paper (as a share of the initial value of savings) is defined by its current value relative to the guaranteed floor value at the time the contract expires, according to:

(5)

whereas the current value of the cost of the contract to the investor is:

(6)

This sum includes several components for the pension institution: (1) hedging cost, i.e., the cost of the purchase option that hedges the exposure of *Z*% of the benchmark index return, (2) operating expenses, including fees paid by the pension institution for the purchase of the option, and (3) the fee (profit) that the issuer of the structured product demands for selling the structured product to its customers, according to the following rule:

(7)

where *C* is the cost of the option in Equation (14), *J* is operating expenses, measured as a percentage of the total hedging costs, and *M* is the pension institution’s fee, expressed as a percentage of the total initial investment at the time the contract is signed.

From Equation (7), one may easily calculate the value of *Z* that relates to the share of the benchmark index return that may be guaranteed to the member under the terms of the structured product, according to:

(8)

At this point, several insights about the proposed structured product may be drawn. (1) The contract between the pension institution and the member ends at the time the purchase option on the benchmark index expires; therefore, this is a European option; (2) The collection fee (*M*% of the total investment) incentivizes the institutional entity to issue the structured product to the broadest possible population of customers. (3) The institutional entity is also incentivized by the terms of the contract, which assure a constant population of customers that cannot switch funds at any time during the period up to the sale of the structured product. (4) The structured product allows the institutional entity to protect investors against a decrease in the value of their pension portfolio without assuming the risk itself, thereby safeguarding its stability.[[16]](#footnote-17) The insurance component for the investor is structured into the purchase of the purchase option and risk-free bonds, and therefore the pension institution, which serves as a financial marketing agent for the structured product, benefits from a guaranteed profit at a very low risk. (5) The structured product may be a propitious solution for the population of pension savers, most of whom are risk-adverse and prefer a safe investment that usually yields a low return. The structured product offers the investor a good alternative to an investment that hedges against unforeseen losses, which may deliver a higher return by means of exposure to the capital market (in comparison with the low return on an investment in government paper). (6) Investors differ widely in their levels of risk aversion, manifested in their preferences of the level of guaranteed return on their portfolios and the percent of their exposure to the capital market. The proposed structured product allows the issuer to be flexible in setting the percent of the guaranteed return, thus allowing it to tailor the product to investors’ demands. (7) Under certain market conditions, the structured product may also be a good substitute for earmarked bonds as an instrument that mitigates the risk of a decline in the value of pension savings; thus, it may help the government to downsize its pension undertakings.

2.2 Numerical Example

Below is an example of setting the rate of return on exposure to a benchmark index of the equity market, given several parameters from the market data and the risk aversion of an investor who is interested in fully hedging the value of his or her pension portfolio (*G* = 0%), which is estimated at *B0*=$100,000. The structured product protects the investor against a decrease in value for a period of one year going forward (*T=1*) and guarantees a *Z*% exposure to the expected increase in the benchmark index during the period in question.[[17]](#footnote-18) We assume that the benchmark index of the equity market generates a dividend return of *q* = 3%, the risk-free interest rate (in annual terms) derived from the yield on government paper is *r* = 4%, and the annual standard deviation of the index return is . The issuer charges a fee of *M* = 0.5% for selling the structured product, knowing that the issuer’s operating expenses are *J* = 1% of the total hedging costs, which are estimated according to Equation (3) at *C* = $0.0626. Under these constraints, the structured product can guarantee the member an exposure of up to 54.034% of the positive return on the index (if such exists) according to Equation (8):

Under these assumptions, the costs to the investor of buying the structured product at time *T* = 0 and their share of the initial portfolio value (in parentheses) may be calculated as follows:

Investment in risk-free bonds (96.07%):

Issuer’s fee (0.5%):

Capital allocation for operating expenses (0.03%): $33.87

Capital allocation for hedging expense per B&D (3.41%): $3387.18

Total investor’s expenses: $3921.05

Ultimately, the potential return on the investor’s pension portfolio through the structured product is derived from the return on the benchmark index at the end of the period (relative to the initial level of the index) and from the characteristics of the structured product as determined at the beginning of the period, which specify the share of the index return that the investor will receive. As stated, these characteristics are determined in accordance with the guaranteed floor return that the investor demands, the risk-free interest rate, and the volatility of benchmark index prices as measured on the basis of market data.

3. Methodology

In this section, we describe the way the database is created by means of Monte Carlo simulations and explain the methodology used to analyze the simulation results.

3.1 Creating the Database by Means of Simulations

Here we are interested in profiling the conditions under which an investor may be guaranteed a minimum return on his or her pension savings by purchasing the structured product for a term of one year ahead (*T = 1*). We create the profile by analyzing the sensitivity of the characteristics of the structured product (*Y, Z*) as a function of the risk-free interest rate and the volatility of equity prices and as a function of the guaranteed return level that the investor demands. This analysis should indicate under what market conditions the investor can be offered a guaranteed return, how much they will have to pay to insure this outcome (*Y*), and the portion of the benchmark index return that they will receive (*Z*). We make several assumptions concerning the market data and the costs of performance, including: the dividend return on the benchmark index is constant at *q* = 3%; the issuer charges a fee of *M* = 0.5% for selling the structured product; and the issuer’s operating expenses are *J* = 1% of its total hedging costs.[[18]](#footnote-19)

To demonstrate this, we present a sensitivity analysis of *Z* as a function of market conditions for three types of investors differentiated by their levels of risk aversion: (1) a relatively risk-loving investor, who wishes to increase their exposure to the capital market and, in return, to set a floor value of 97% of the value of their portfolio (G = -3%); (2) an average investor, who wishes to increase their exposure to the capital market in return for hedging their pension savings (*G* = 0%); and (3) an investor who wishes to assure a minimal return of *G* = 2% in return for a smaller exposure to the capital market.

The structured product is examined against a pension portfolio management strategy that includes a *Z*% direct investment in the equity market and 1 – *Z*% in risk-free bonds, by comparing the returns on the two portfolios. To calculate these returns, we run a Monte Carlo simulation that describes the movement of the benchmark index of the equity market by means of a Geometric Brownian Motion. The simulation calculates the return on the equity index from the day the contract is signed to the day it expires, according to:

(9)

where is the index return at the end of time *T* in Simulation *i*, is the expected annual index return, is the standard deviation of the underlying asset price, and *𝜀* is a noise factor sampled from the standard normal distribution.[[19]](#footnote-20) By means of the index return obtained in the simulation (), we calculate the return on the member’s pension investment by means of the structured product against the alternative of a managed investment fund , according to:

(10)

It should be clarified that the index return of the simulation in Equation (9) is determined on the basis of the expected annual return and the standard deviation of the index, which are not known in advance; therefore, a forecasting problem exists. We chose to determine the expected yield on the basis of a fixed spread of 4% over the risk-free interest rate and to determine the standard deviation on the basis of three different market scenarios: (1) low volatility (), which reflects a period of calm in which no major change in equity prices occurs; (2) medium-to-high volatility (, representing a time when the market drifts slightly over the multi-annual average in the past few decades; and (3), high volatility, , simulating a time of financial crisis.[[20]](#footnote-21) The simulation is calculated across period *T* = 1, and in calculating the return on the structured product, we assume that the investor buys the product at the beginning of the year.

3.2 Analysis of Simulation Outcomes

Here we compare and examine the simulation outcomes and investment strategies by means of stochastic dominance tests and various return and risk indicators.

Stochastic Dominance Tests

First we compare the investment strategy set forth by Quirk and Saposnik (1962) and Hadar and Russell (1969) by means of first-order and/or second-order stochastic dominance tests for the return on the structured product in contrast to the return on an investment portfolio composed of underlying assets. First-order stochastic dominance of Portfolio A over Portfolio B is defined by:

(11)

whereas second-order dominance of Portfolio A over Portfolio B is defined by:

(12)

where is the portfolio return and is the cumulative distribution function (CDF) of the portfolio return. According to Quirk and Saposnik (1962), first-order stochastic dominance of Portfolio *A* over Portfolio *B* is indicative of a higher probability that Portfolio *A* will deliver a return greater than *R*, whereas second-order dominance suggests that the expected yield of Portfolio *A* will not exceed that of Portfolio *B*. The CDF of the two investment paths is estimated empirically by a kernel density estimation across the portfolio returns at the expiration time obtained from the simulation, which is calculated by:

(13)

where is the estimated density function, *n* is the sample size, is the kernel function—a positive function that performs an integration to 1 with expectation 0—and *h* is a parameter that controls for the extent of smoothness of the estimated density function, which is determined optimally in accordance with the data.

Return versus Risk Analysis

We now compare the performance of the portfolios using analytical methods that assume that investors choose investment portfolios that maximize the expected utility of the portfolio—optimal choice among the distributions of the portfolio returns on the basis of distribution moments, such as average excess return over risk-free interest, standard deviation of the returns, and the Sharpe Ratio (Annaert, Van Osselaer, and Verstraete, 2009). These indicators, however, are not sufficient because they disregard the risk reflected in asymmetric distribution and the “left-hand tail” of the yields. Sortino and Price (1994) propose testing low returns that fall short of the Minimum Acceptable Return (MAR), and, in particular, examination of the ratio of the average excess return over MAR to the measured standard deviation of sub-MAR returns (downside deviation), by:

(14)

where the numerator is the average of returns exceeding MAR and is the standard deviation of returns over MAR as calculated by .

In this context, studies such as those of Jorion (2001) and Ibragimov and Walden (2007) focus on VaR (value at risk) as an indicator of the risk asymmetry that describes the portfolio loss at a high confidence level (usually 95%). However, given that the VaR indicator does not describe the expected size of the loss, studies such as those of Acerbi and Tasche (2002) and Rockafellar and Uryasev (2002) focus on Conditional Value at Risk (CVaR), the value of which is the average loss below VaR.

To compare the portfolios in our possession, we calculate VaR and CVaR indices as indicators of the risk exposure of the member’s portfolio, as well as the Sharpe Ratio and the Sortino Ratio, which reflect excess return relative to risk level. We compute them on the basis of the returns of the structured product and those of the alternative investment portfolio, which is based on underlying assets. By comparing their values, we get an indication of the levels of risk and performance of these two different strategies.

4. Results

4.1 Sensitivity of Structured-Product Characteristics to Market Conditions

The following results present a sensitivity analysis of the characteristics of the structured product (*Y, Z*) as a function of possible risk-free interest rates, the annual standard deviation of the daily return on the benchmark index, and the guaranteed rate of return that the investor demands. Figure 1 shows the maximum *Z* value of the benchmark return index that the issuer can offer the investor as a function of the guaranteed return that the investor demands and as a function of the risk-free interest rate, *r*, and the annual standard deviation, , of the equity market.[[21]](#footnote-22) Notably, under high-volatility conditions in the benchmark index, the structured product is unlikely to be issued because it would be expensive and unattractive. We nonetheless present this scenario for the purposes of the analysis and to demonstrate the problematic high volatility of the structured product market.

Figure 1 describes *Z* as a function of the risk-free interest rate at the standard deviation of the equity index for three different investors. As expected, the results show that settling for a guaranteed rate of return that is lower than the risk-free interest rate raises the percent of exposure to the index that the structured product can offer the investor. To demonstrate this, assume that r = 3% and  = 10%. In this case, an investor who wants a guaranteed return of *G* = 2% will accept a *Z* = 13% rate of exposure to the index, in contrast to an investor who is interested in guaranteeing the principal only (*G* = 0%), who will accept *Z* = 63%. The reason for this outcome is that guaranteeing a return that verges on the market interest rate makes it possible to buy purchase options (for hedging purposes) in a lower amount; therefore, it allows only a lower rate of exposure to the benchmark index return.

**Figure 1.** The maximum portion (*Z*, in pct.) of the benchmark index return that the issuer can offer the investor as a function of the risk-free interest rate and the annual standard deviation of the benchmark index return to the equity market. The figure presents a sensitivity analysis for three different types of investors: (1) one seeking to guarantee payout at the level of 97% of their portfolio (*G* = -3%); (2) one interested in guaranteeing the principal only (*G* = 0%); and (3) one seeking a minimal return (*G* = 2%). The structured product is defined to a term of one year ahead (*T* = 1) under the assumption that the dividend return of the index is *q* = 3%, the issuer’s fee is *M* = 0.5% of the value of the investment, and the issuer’s operating expenses are *J* = 1% of total hedging cost.

Figure 1 shows that *Z* is rather strongly affected by the market’s risk-free interest rate and that a higher percentage than the index return can be attained when the risk-free rate rises. The results indicate that in a low interest rate environment of 0.1%–5%, such as that in effect today, a positive return, and even the investors’ principal cannot be guaranteed. Therefore, an investor interested in buying the structured product will have to settle for protection of only some of their savings. The results show, however, that the structured product can guarantee payment of the principal in an interest environment higher than 1% and can assure a 2% return in a risk-free interest environment that trades at more than approximately 3%.

Figure 1 also shows that the annual standard deviation of the equity price index has a considerable effect on Z. To demonstrate this, when the risk-free interest rate is *r* = 4%, the structured product offers an investor who wishes to protect only the principal (*G* = 0%) a relative share of only *Z* = 34% when equity prices are highly volatile ( = 25%), compared to *Z* = 78% when equity trading is relatively stable ( = 10%). The perceptible spread of *Z* is the result of the sizable increase in the price of the option pursuant to the widening of the standard deviation. Therefore, at times of uncertainty, in which equity prices are acutely volatile (as during the subprime crisis), the financial institution will probably find it difficult to offer investors a structured product that guarantees a return. At such times, most investors flee to safety, mostly by purchasing high-quality assets that are considered safer, as reflected in Longstaff (2004) and Naes et al. (2011). Therefore, at such times, a guaranteed return structured product will probably be much in demand despite the relatively low rate of return that it offers customers on the equity index.

To clarify, we note that the cost of the structured product to the investor falls as a function of the guaranteed rate of return that the investor chooses relative to a given risk-free interest rate *r* at the same point of time, since investors who are interested in a guaranteed return that verges on *r* will pay much less than would investors who wish to ensure lower uninterrupted payouts from their portfolios (in return for a higher percent of exposure to the market return). Accordingly, when the risk-free interest rate rises, investors may be offered a higher guaranteed return with no major change in the cost of the product to them (see Appendix 1).

In sum, the results show that the structured product can insure the value of a pension portfolio under various market conditions, but the level of the guaranteed return varies largely commensurate with the conditions of market interest. Generally speaking, at interest conditions of more than 3%, the structured product can provide a good solution for most pension savers, enabling them to profit from a potential upturn in the equity market while hedging against a decrease in market value. In particular, in a normal time of low volatility in equity prices, the structured product provides a relatively high rate of exposure to the equity market index and, therefore, may be a rather good alternative investment to buying and holding the index. The quality of investment of the structured product relative to the performance of the portfolio comprised of a *Z*% investment in the equity market index and 1 – *Z*% at the risk-free interest rate is examined by means of a Monte Carlo simulation for each of the three prototype investors, each characterized by the minimum guaranteed return that the investor demands (*G*).

4.2 Results of the Simulation

The following simulation results describe the pension portfolio return for a person who invests in the structured product (SP) relative to the return on investment portfolio that is balanced in terms of its exposure to the index. The return is measured from the day the contract is signed to the day on which it expires, under the same assumptions of a dividend return of *q* = 3%, an *M* = 0.5% issuer’s fee, and operating expenses at *J* = 1% of the issuer’s total hedging cost. The benchmark index for the equity market is typified at an annual frequency by means of Geometric Brownian Motion across 10,000 simulations, each describing possible changes in the prices of the equity index for a period of one year ahead. Pursuant to the initial findings, most of the discussion will focus on market conditions in which interest exceeds 4%, under the assumption that the expected annual return of the equity market exceeds the market’s risk-free interest rate by 4%. The results show first- and second-order stochastic dominance tests of the return of the structured product relative to the return of a balanced investment portfolio by means of Figure 2. They also juxtapose the average return of the structured product with that of the investment portfolio as well as the risk indicators (VaR, CVaR) and metrics for comparison with the portfolios’ performance (Sharpe Ratio, Sortino Ratio) to one year ahead (Table 1). These results are presented for the three investors examined, who are differentiated by the guaranteed rate of return, *G,* that they demand.



**Figure 2.** First- and second-order stochastic dominance tests of the defined-benefit structured product, compared to a portfolio that has a balanced rate of exposure to the index return, to an investment term of one year ahead. The figure presents the differences of the cumulative distribution function (CDF) and the sum of CDFs of the estimated kernel function of the return of the structured product relative to the investment portfolio, yielded in a Monte Carlo simulation. The simulation results are calculated for different guaranteed return rates: G =

-3%; and 0%, under various equity market risk scenarios of  = 55%, 25%, and 10%, where the risk-free interest rate is *r* = 4% and the expected equity market return is . It is assumed that the dividend return of the index is *q* = 3%, the issuer’s fee is *M* = 0.5% of the initial investment, and the issuer’s operating expenses are *J* =0% of total hedging cost.

Figure 2 gives a visual presentation of first- and second-order stochastic dominance tests for the return on the structured product (SP) compared to a balanced investment portfolio on the basis of the difference between the cumulative distribution function (CDF) and the sum of the CDFs according to Equations (11) and (12), respectively, where the CDFs are estimated by means of the kernel function across the returns of the structured product and the weighted investment portfolio by means of a Monte Carlo simulation. By this definition, a negative difference (across the full range of existing returns) indicates stochastic dominance of the structured product over the weighted investment portfolio. The figure presents stochastic dominance tests that examine the return on the structured product as a function of different rates of guaranteed return (G = -3%, 0%), and as a function of different risk scenarios of the equity index ( = 55%, 25%, 10%), where the risk-free interest rate is *r* = 4% and the expected equity market return is .

While the results in Figure 2 do not show first-order stochastic dominance, in certain cases, the structured product has second-order stochastic dominance over the investment portfolio, chiefly when the level of equity market risk is not high. To substantiate this, when index volatility is low ( = 10%), the difference of the sum of the CDFs is negative at any possible rate of return, whether the structured product guarantees a floor of 97% of the portfolio (G = -3%) or the principal only (G =0%). Accordingly, in these cases, the expected return on the structured product exceeds the expected return of the investment portfolio when price volatility in the equity market is low. The figure shows that no second-order dominance exists when the structured product guarantees a return of G =2%. Alternatively, Figure 2 demonstrates that when market risk is high,  = 55%, the difference of the CDF is positive, suggesting that the investment portfolio has second-order stochastic dominance over the structured product. Nevertheless, such a large standard deviation is usually typical of a time of crisis in the equity market. Therefore, at such a time, the prices of options on the market will probably be so high as to stop the issuance of these structured products or, at least, make them much less attractive until the market settles down.

The returns on the various investment portfolios, obtained from a Monte Carlo simulation, are itemized in Table 1, which describes the performance of the structured product to a one-year term compared to the balanced investment portfolio under various equity index risk scenarios and different guaranteed rates of return. Pursuant to the findings in Figure 2, the simulation results show that when the risk level in the market is low ( = 10%), it is almost always better to invest in the structured product than in the balanced portfolio because it delivers a higher average return and a lower level of risk, as reflected in the Standard Deviation.

**Table 1**

Structured product performance compared to a weighted investment portfolio under various market conditions ( = 55%, 25%, 10%) and various guaranteed return rates ( = 55%, 25%, 10%). The table shows the performance of returns of the structured product compared to the balanced investment portfolio across a range of comparison indicators: average portfolio return, standard deviation, VaR and CVaR, Sharpe Ratio, and Sortino Ratio. The returns delivered by the structured product were calculated by means of a Monte Carlo simulation that included a simulation of 10,000 annual returns on the S&P 500 Index, assuming an expected return on the equity portfolio and *r* =4% risk-free interest, under various conditions of market volatility.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Index** | σ=55% | | σ=25% | | σ=10% | |
| **Guaranteed return** | Portfolio | SP | Portfolio | SP | Portfolio | SP |
| G =-3% | **Avg.** | 0.052 | 0.0474 | 0.0669 | 0.0621 | 0.1035 | 0.1067 |
| **S.D.** | 0.192 | 0.1486 | 0.1741 | 0.1289 | 0.1593 | 0.1308 |
|  | **Sharpe** | 0.0623 | 0.050 | 0.1543 | 0.1713 | 0.3984 | 0.5098 |
| **Sortino** | 9.8795 | 22.029 | 17.9197 | 62.642 | 40.124 | 157.78 |
|  | **VaR** | 0.1588 | 0.03 | 0.1784 | 0.03 | 0.1446 | 0.03 |
|  | **CVaR** | 0.1796 | 0.03 | 0.219 | 0.03 | 0.1967 | 0.03 |
| G =-0% | **Avg.** | 0.0463 | 0.042 | 0.0541 | 0.05 | 0.0734 | 0.0742 |
|  | **S.D.** | 0.1011 | 0.0806 | 0.0917 | 0.07 | 0.0839 | 0.071 |
|  | **Sharpe** | 0.0623 | 0.0251 | 0.1543 | 0.1426 | 0.3984 | 0.4814 |
|  | **Sortino** | 12.998 | 3.5551 | 22.2919 | 18.5435 | 48.755 | 61.221 |
|  | **VaR** | 0.0647 | 0 | 0.075 | 0 | 0.0572 | 0 |
|  | **CVaR** | 0.0756 | 0 | 0.964 | 0 | 0.0846 | 0 |
| G =-2% | **Avg.** | 0.0427 | 0.0384 | 0.0461 | 0.0419 | 0.0544 | 0.0525 |
|  | **S.D.** | 0.0434 | 0.0353 | 0.0394 | 0.0307 | 0.036 | 0.0311 |
|  | **Sharpe** | 0.0623 | -0.045 | 0.1543 | 0.0621 | 0.3984 | 0.4021 |
|  | **Sortino** | 9.801 | -5.915 | 18.678 | 6.3166 | 35.117 | 31.81 |
|  | **VaR** | 0.005 | -0.02 | 0.0094 | -0.02 | 0.0018 | -0.02 |
|  | **CVaR** | 0.0097 | -0.02 | 0.0186 | -0.02 | 0.0136 | -0.02 |

To demonstrate this, the average return on a structured product that guarantees the investor’s principal (*G* =0%) is slightly higher, 0.0742 compared to 0.0734, and the standard deviation is much lower (0.071 compared to 0.0839). This is reflected in both the Sharpe Ratio and the Sortino Ratio, which show the structured product outperforming the investment portfolio. To demonstrate this, for a structured product that guarantees the principal (*G* =0%), the Sharpe Ratio is 0.481 compared to 0.398, reflecting a much higher return than that obtained on the investment portfolio at the same level of risk. Furthermore, when values at risk (VaR and CVaR) are taken into account, the value at risk of the structured product is commensurate with the guaranteed return of the product, which, in any case is far below the value at risk of the investment portfolio based on underlying assets, for any guaranteed rate of return. Accordingly, when the annual standard deviation of the equity market reflects low risk, the findings show that it is better to invest in the structured product than in the alternative, i.e., the investment portfolio, because the structured product usually gives a return that is higher than or equal to the measured return on the investment portfolio as long as the investor is not exposed to a loss (beyond the value defined in the guaranteed rate of return).

These findings illustrate the attractiveness of the structured product for the average investor, who, for the most part, is interested in increasing their exposure to the market without being exposed to any risk. Therefore, in our estimation, and under these conditions, the structured product will be in demand among pension savers because it promises to concurrently hedge the portfolio and deliver a return that, for the most part, will exceed that of an investment portfolio equally exposed to the capital market.

However, when we observe periods in which the equity market responds at a medium- to high-risk level, we find the opposite trend in some cases, where the investment portfolio outperforms the structured product. Apart from a scenario of  = 25% market risk, in which a structured product that guarantees the customer a floor value of 97% of the principal (*G* = -3%) delivers a better return at the same risk level on the basis of the Sharpe Ratio and the Sortino Ratio, in the other cases, the investment portfolio outperforms the structured product as reflected in the stochastic dominance of the investment portfolio over the structured product in Figure 2. These outcomes, however, should be treated with caution, particularly in the case of  = 55%, because most such cases arise at a time of financial crisis, in which the equity market is usually typified by falling prices. Therefore, in contrast to the results of the simulation in these cases, we would usually expect to see a lower, if not negative, return. Under these conditions, it is likely that the structured product would deliver a higher return than the investment portfolio because it limits the investor’s loss. This finding is also reflected in the Sortino Ratio, which shows that, at any given level of risk, a structured product that gives the investor *G*= -3% provides a much higher return on the investment portfolio than the risk level measured across the loss. Therefore, in these cases, too, a structured product that provides a guaranteed return would probably be in greater demand than the investment portfolio.

In sum, the results show that, under certain market conditions, the structured product that we have developed may be worthwhile for most types of investors who wish to protect their pension savings. In an interest environment of 3% or more, and under trading conditions that reflect a low level of risk ( = 10%), the structured product is advantageous for investors who wish to protect their pension savings. Furthermore, in cases where the structured product gives partial or full hedging of the pension savings portfolio (*G* = -0.3% and *G* = 0%, respectively), it has second-order stochastic dominance over investment portfolio and gives the investor a much higher return than does the balanced investment portfolio at the same level of risk. Under these conditions, the structured product also improves the safety of their investment and therefore, generally speaking, is advantageous to the average risk-averse investor. Accordingly, insofar as the short-term interest rate rises over its low level, trading at around -0.2% in the Eurozone countries and 0.64% in the United States (OECD, 2017), for a range of more than 3% or so, the structured product can be marketed to a considerable portion of the pension saving public in developed countries as a hedging instrument against the loss of value of pension savings.[[22]](#footnote-23) In the same context, Figure 1 shows that even in at a low interest rate, the structured product can guarantee investors some kind of floor level for their investment portfolio. Therefore, even in a zero-interest environment, it may be an attractive alternative investment for those interested in hedging investment risks. Since no major change in the monetary lending rate in many OECD member states (particularly in the Eurozone) is expected in the near future, the structured product may also be a good investment solution for pension fund members who wish to protect their portfolios in full.[[23]](#footnote-24)

5. Summary and Conclusions

The trends observed in numerous OECD countries of switching from DB pension plans to DC programs and an increase in the exposure of institutional players’ investments to the capital market have triggered a powerful increase in risk to the pension savings of pension fund members. This kind of risk is expected to intensify in coming years as the transition to DC pension plans in developed countries gathers momentum (OECD, 2016), as is expected, and as pension saving institutions become more active in investing in the capital market, particularly equities and bonds, as reflected in the Israeli case in the past decade. It is true that exposure to the capital market improves the likelihood of a high return that is likely to contribute to a major increase in the member’s total pension savings. Conversely, however, it aggravates the risk to members, particularly those nearing retirement, due to the exposure of their pension savings to the volatility of the capital market. In a departure from the past, DC pension plans do not protect pension savings; therefore, the upturn in exposure to the capital market may prove burdensome to risk-averse investors, most of whom seek a guaranteed return on their pension savings in order to secure their financial future in their retirement years.

The structured product presented in this study allows pension institutions to satisfy investors’ demand for a guaranteed floor and a level of exposure to the capital market. Therefore, it may prove a better financial product than what is offered today. The results of our study show that under higher interest conditions than those of the present, the structured product may guarantee a minimum return on members’ pension portfolios that concurrently strongly reduce their investment risk and allow them the possibility of profiting from partial exposure to a benchmark index of the equity market. Furthermore, the results of the study show that when trading conditions in the equity market are stable (a situation reflected in a low standard deviation), the structured product is able to give investors a high percentage of exposure to the equity market index, which ultimately delivers an average return that resembles, and in some cases even surpasses, the return on a pension investment portfolio composed of investing *Z*% in the equity market index and 1 – *Z*% in risk-free interest. Accordingly, under these conditions, the structured product is a better investment alternative for the investor because it offers him or her an investment that is less risky and more profitable than the investment portfolio alternative.

In this context, the structured product offers investors a safe low-risk investment vehicle that generates a much higher return than that obtained by investing at risk-free interest. For this reason, those interested in hedging their pension savings may also find the structured product, as an investment alternative, a worthwhile way to invest in risk-free bonds.

By allowing institutional players to define it under changing market conditions, the structured product gives them a competitive edge. Therefore, the marketing of this product by these institutions may make pension institutions very popular among the pension saving public and bring about a major change in the pension saving industry in the OECD member states. Apart from enabling pension institutions to insure their members without real risk to themselves, therefore giving the government confidence in their stability, we believe the structured product may revolutionize the pension saving market in the OECD member states.

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Appendix 1

Cost of insurance to the investor (*Y*) (in pct.) as a function of risk-free interest and the level of guaranteed return that he or she demands. Hedging cost is measured relative to an alternative investment in risk-free government paper, with *Y* as the alternative interest rate that the investor pays the issuer for his or her purchase of the structured product. The structured product is defined to a term of one year ahead (*T* = 1).

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Risk-free interest (r)** | | | | | | | | | | **Guaranteed return (G)** |
| 8% | 7% | 6% | 5% | 4% | 3% | 2% | 1% | 0.5% | 0.1% |
| 13.33% | 12.25% | 11.18% | 10.13% | 9.08% | 8.05% | 7.02% | 6.01% | 5.50% | 5.10% | **-5%** |
| 12.33% | 11.25% | 10.18% | 9.13% | 8.08% | 7.05% | 6.02% | 5.01% | 4.50% | 4.10% | **-4%** |
| 11.33% | 10.25% | 9.18% | 8.13% | 7.08% | 6.05% | 5.02% | 4.01% | 3.50% | 3.10% | **-3%** |
| 10.33% | 9.25% | 8.18% | 7.13% | 6.08% | 5.05% | 4.02% | 3.01% | 2.50% | 2.10% | **-2%** |
| 9.33% | 8.25% | 7.18% | 6.13% | 5.08% | 4.05% | 3.02% | 2.01% | 1.50% | 1.10% | **-1%** |
| 8.33% | 7.25% | 6.18% | 5.13% | 4.08% | 3.05% | 2.02% | 1.01% | 0.50% | 0.10% | **0%** |
| 7.33% | 6.25% | 5.18% | 4.13% | 3.08% | 2.05% | 1.02% | 0.01% |  |  | **1%** |
| 6.33% | 5.25% | 4.18% | 3.13% | 2.08% | 1.05% | 0.02% |  |  |  | **2%** |
| 5.33% | 4.25% | 3.18% | 2.13% | 1.08% | 0.05% | - |  |  |  | **3%** |
| 4.33% | 3.25% | 2.18% | 1.13% | 0.08% | - | - |  |  |  | **4%** |
| 3.33% | 2.25% | 1.18% | 0.13% | - | - | - |  |  |  | **5%** |
| 2.33% | 1.25% | 0.18% | - | - | - | - |  |  |  | **6%** |
| 1.33% | 0.25% | - | - | - | - | - |  |  |  | **7%** |
| 0.33% | - | - | - | - | - | - |  |  |  | **8%** |

1. In a DB pension arrangement, the guiding financial principle is that the worker accrues rights that assure a constant future payment from point of pension retirement to death, paid for by the employer, with the future guaranteed annuity usually based on a formula ling the worker’s wage and the number of his or her years with the employer. In a DC plan, in contrast, workers’ savings are accumulated by periodic withholding of a given share of wage (usually with matching contributions by the employer) to a separate pension fund that manages the money so that the worker’s total pension savings are contingent both on the accrued deposits and on the return attained in accordance with the type of investment made by the pension fund. [↑](#footnote-ref-1)
2. In some countries, such as the United States, Japan, and the United Kingdom, there are pension funds that offer hybrid schemes that combine the principles of DB and DC. Such plans are usually treated as DB for tax and accounting purposes, but the pension savings of the worker are insured on the basis of the balance in the worker’s account with the pension fund, which, for the most part, is paid out as a lump sum at point of retirement. [↑](#footnote-ref-2)
3. The data pertain to seventeen countries for which there were data for the 2001–2012 period. [↑](#footnote-ref-3)
4. An OECD report for 2016 shows that DB pension plans are not offered in eight countries—France, Estonia, Hungary, Greece, Slovakia, Poland, the Czech Republic, and Chile—and account for a very negligible share (less than 10% of total pension payout to workers) in Denmark and Italy. [↑](#footnote-ref-4)
5. Bodie and Crane (1999) show that many countries have made major changes in their pension industries in response to financial pressure on firms and government entities. The changes include, but are not limited to, raising the retirement age, lowering the pension replacement rate (the ratio of total pension to wage), and lowering investment restrictions on these firms in order to enhance returns. [↑](#footnote-ref-5)
6. In most DC plans, workers can avoid the risk of an increase in life expectancy by purchasing a structured product that pays a fixed annuity during their pension term; this, however, exposes them to the cost of this product. [↑](#footnote-ref-6)
7. Spivak and Yosef (2005) show that the veteran pension funds’ deficits were misreported and overstated for reasons including the use of incorrect actuarial assumptions, such as out-of-date actuarial tables, and more. [↑](#footnote-ref-7)
8. Until March 1995, most veteran pension funds guaranteed a 5.57% minimal return on members’ savings by purchasing earmarked bonds (known as *hayim-tsamud* [“indexed for life”] bonds) that the Israeli government issued to pension funds and insurance companies, which, in turn, were required to invest at least 93% of their investment portfolio in them. Under the 2003 pension reform, the rules of investment for veteran and new pension funds were revised so that their holdings of earmarked bonds were reduced to 30% of the value of assets managed (instead of at least 93% for veteran funds and 70% for new funds before the reform). This was done gradually, commensurate with the redemption dates of the existing bonds, by which their return would be set at only 4.86%. However, the veteran pension funds were required to maintain a solid investment mix including investment of at least 50% of assets managed in tradable government bonds and 13% in government bonds and deposits rated A or over. [↑](#footnote-ref-8)
9. In its report, the Bachar Commission found a structural conflict of interest in the banks’ business activity: on the one hand, banks were managing customers’ money and, on the other hand, they were advising their customers in investing in financial products and selling such products (including securities, mutual funds, and structured bank deposits) and pension products (including provident funds and life insurance) in which they had an interest. [↑](#footnote-ref-9)
10. Bank of Israel data show that institutional players in Israel increased their share of holdings in tradable corporate paper from 4.2% to more than 15% between 2004 and 2007. [↑](#footnote-ref-10)
11. Average real yield for the period between January and December 2008. The data relate to new pension funds only. [↑](#footnote-ref-11)
12. In accordance with the conclusions of a committee that had been appointed to enhance certainty in pension savings, Ministry of Finance, January 2016: <http://www.mof.gov.il/Committees/PensionSavingTeamCommittee/PensionSavingTeamCommittee_Report.pdf> [↑](#footnote-ref-12)
13. Under the terms of the reform, pensioners will receive an allocation of earmarked bonds at 60% of the value of their pension savings, those over age 50 will get 30%, and those up to age 50 will not be entitled to any allocation of earmarked bonds whatsoever. The reform will be implemented gradually over a thirty-year period, such that the share of earmarked bonds for young savers will fall to only 15% twenty years on. [↑](#footnote-ref-13)
14. According to data for 2015 (OECD 2016), the average investment by pension institutions in bonds and equities exceeded 75% of the investment portfolio’s value in twenty-four OECD member states and exceeded 85% in fifteen countries. [↑](#footnote-ref-14)
15. The option acquired by the pension institution is adjusted so as to be quoted at the exercise price commensurate with the current value of the benchmark index at the time the structured product is sold for the customer (an in-the-money option) and on an expiration date that corresponds to the expiration date specified in the structured product. Thus, insofar as the option cannot be exercised at point of expiration (i.e., if the price of the benchmark index at the time of expiration is below the exercise price), the pension institution loses the premium that it paid for acquiring the option. [↑](#footnote-ref-15)
16. Over long periods of time, the institutional entity would probably prefer a strategy of buying purchase options to a term to maturity shorter than *T* (doing so several times until the contract ends) in order to lower the cost of buying the option. This strategy exposes the institutional entity to a risk originating in an increase in market volatility (which, if realized, would make the option much costlier); accordingly, the institution may demand a higher premium from the investors. However, due to market competition and its interest in attracting customers, the institutional entity would probably have to assume some of this risk itself. [↑](#footnote-ref-17)
17. The calculations relate to the net index value after dividend payments (and not to an index that includes dividend reinvestment). [↑](#footnote-ref-18)
18. We also carried out a sensitivity analysis of *Z* as a function of the issuer’s fee and operating expenses; the outcomes of the analysis were not substantially different. We chose to present the analysis at *M* = 0.5%, the highest cumulative fee that can be charged to a member to a new comprehensive pension fund in Israel (under the Supervision of Financial Services [Management Fees] Regulations, 5772-2012). [↑](#footnote-ref-19)
19. in Equation (9) describes a gross return of the index at the end of time *T*. [↑](#footnote-ref-20)
20. To demonstrate a large or small standard deviation, we calculated the annual SD of the S&P 500 Index for the daily return during 2005–2015 by using an EWMA time series with a lambda coefficient of 0.94, as in Hull (2012). The results showed that under normal market conditions (such as those before and after the crisis), the annual SD ranges from 7% to 12%; during the subprime crisis (September 2008–March 2009), in contrast, it was roughly 55%. [↑](#footnote-ref-21)
21. We assume that in a competitive market in which several institutional players offer their customers a structured product, the contracts will converge toward the maximum *Z* values that can be paid to the customer. [↑](#footnote-ref-22)
22. Based on daily average short-term (three-month) yields on government paper: <https://data.oecd.org/interest/short-term-interest-rates.htm#indicator-chart> [↑](#footnote-ref-23)
23. This is based on an estimate of expected short-term interest for 2018 in the OECD member states: <https://data.oecd.org/interest/short-term-interest-rates-forecast.htm#indicator-chart> [↑](#footnote-ref-24)