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### **ADEQUACY OF INFLATION-INDEXED LIFE ANNUITY: A CASE OF DEFINED CONTRIBUTION PENSION PLAN IN MALAYSIA**

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#### **ABSTRACT**

Defined Contribution (DC) pension plans in some Asian countries are currently operated by the lump-sum withdrawal scheme, which allows retirees to withdraw all accrued savings in a single withdrawal. This type of withdrawal does not protect pensioners from the longevity risk. This study examines the adequacy of an alternative for the lump-sum withdrawal system, namely the withdrawal system based on the Inflation-Indexed Life Annuity (IILA). This study proposes two types of IILA: the immediate IILA and the deferred IILA. The adequacy of a life annuity is measured using the ratio of projected wealth to the projected consumption at the retirement age. For the deferred IILA, this study uses the Euler-Lagrange method to assess the optimal amount that will be set aside to finance the annuity scheme. The IILA and deferred IILA will protect retirees from purchasing under-valued annuities by adjusting the IILA to inflation risk. Furthermore, deferred IILA may improve the life quality of retirees by providing adequate retirement income during the deferment years. Analysis of data from the Household Income and Expenditure Survey (HEIS, 2014) indicates that the immediate IILA offers an average lifetime income of over 50%, while the deferred IILA provides more than 40%.

**Keywords:** defined contribution, deferred life annuity, Euler-Lagrange, retirement income, retirement adequacy.

## INTRODUCTION

The pension system in most countries worldwide has undergone a vital transformation from an unfunded pension system, Defined Benefit (DB), to a fully funded pension system, Defined Contribution (DC) pension plan. Unlike DB, DC pension members and their employers make regular contributions from their salary to the retirement account. At retirement, their members can withdraw a sum (or all) of money, which depends on the withdrawal rules by the DC pension system, as the rules differ from country to country.

One of the purposes of the DC pension plan is to protect against longevity risk, which is the risk of having insufficient retirement income as a consequence of old age. For example, the DC pension plan in Sweden, Netherlands, and France require their contributors to purchase an annuity at retirement, the DC pension plan in the United States considers a combination of both annuity and lump sum payment, and the DC pension plan in the United Kingdom consider an annuity as its default case (Emms, 2012). However, in some Asian countries, such as Malaysia, the decumulation of a DC pension plan is merely a lump sum.

Thus, the responsibility to manage longevity risk for this DC pension plan has switched solely to its members. As a result, their members face the issue of withdrawal amounts throughout retirement years. Accordingly, if retirees withdraw too little, they may have to lower their lifestyle standards. Conversely, if retirees withdraw too much, they may run out of money too quickly.

This is highly challenging in most Asian countries, particularly Malaysia, where accessible annuity options have yet to become available. The DC type of pension, which is more prevalent today among such economies, therefore provides only a limited amount of long-term financial security for the pensioner. With the increase in the cost of living and higher life expectancy, there are two pertinent issues: the inflation risk and the longevity risk. Suppose effective annuity solutions are not provided. In that case, there is a risk that retirees may outlive their retirement savings, which is compounded by the fact that inflation erodes the real value of their income over time.

Most pension plans in Malaysia and similar markets have lump-sum payouts that cannot provide retirees with as much financial stability as a regular income stream would have afforded them. However, traditional life annuities hardly exist in these regions, and inflation-indexed annuities almost do not exist, making retirees highly susceptible to economic pressures. Historically, the Employee Providence Scheme (a DC system in Malaysia and throughout this paper will be denoted as 'the DC') has two annuity schemes, namely Skim Anuiti Konvensional KWSP (SAKK) and a shariah compliance version, Skim Anuiti Taqaful KWSP (SATK). However, these schemes have been suspended by the government of Malaysia at the end of 2001.

One such alternative could be introducing IILAs, which would offer a predictable income indexed to inflation during retirement while simultaneously hedging both the longevity and inflation risks. In essence, the introduction of such products in Malaysia is bound to narrow the protection gap in retirement financial planning to sustain their living standard in old age.

The main purpose of this study is to examine the adequacy of IILA to the assumed retirement consumptions using the accumulated savings in the DC pension plan. Other than that, this study also aims to determine how long-accumulated savings in the DC can last if retirees opt to withdraw their

wealth with a strict discipline (self-annuitization) based on assumed consumptions in their working years.

The remainder of this paper is organized as follows. In Section 2, we present the literature reviews. In Section 3, we describe the methodology used in this paper, which includes the wealth process, mortality risk, the pricing and benefit of a life annuity, and the optimization model. In Section 4, we discuss the results, among others, including the background of the DC in Malaysia, the household's consumption, and the adequacy of a life annuity. Finally, we conclude Section 5.

## **LITERATURE REVIEW**

Several attempts have been made to compare the issue of annuity and self-annuitization under a variety of assumptions. Self-annuitization is defined as a form of self-managed withdrawal that retirees perform from their self-regulated investment (Emms & Haberman 2014). In their paper, Emms and Haberman (2014) highlighted that annuitization is preferable if the expected income from self-regulated investment drops below the annuity rate. Furthermore, Bateman et al. (2016) investigated the decision to select between annuity and self-annuitization among 854 Australian retirees. The authors discovered that half of the retirees almost completely disregard the probability of ruin and allocate their accumulated wealth to self-annuitization. Meanwhile, retirees with better financial knowledge are aware of the risk of ruin and allocate their money more to annuity products. Bravo (2017) stated that in comparison to the annuity, self-annuitization tends to solve the issue of idiosyncratic longevity risk. Although the risk is related to a particular individual, it will not be able to solve the systematic longevity risk. In other words, self-annuitization is only suitable for a certain number of retirees, for instance, retirees with more retirement wealth (Foziah et al. 2018).

In terms of advantages among annuities products in the market, life annuities have the upper hand in delivering a series of income at a fixed interval for the annuitant's lifetime (Wang & Young 2012). To our knowledge, the existing papers within the literature on modeling life annuities focus on two vital issues. First, mortality and interest rates are crucial in providing accurate and, second, fair-priced products. Several papers (Fung et al., 2015; Denuit and Trufin, 2016; Bravo, 2017; Shen and Sherris, 2018) utilize the stochastic mortality rate to ensure that the model is robust enough to capture the changes occur in the rate of mortality in the long run. However, modeling the stochastic mortality rate requires an intense amount of data on the number of deaths in a given population, which may not be achievable in certain regions. Furthermore, in practice, it should be noted that random fluctuations occur in the stochastic mortality rate and can be reduced in relative terms as the number of people increases. Also, rather than a new type of risk, the random fluctuation of mortality rate in the future is mainly caused by systematic risks. It will not have a significant impact on a big population. Due to these reasons, there are still recent studies (Asmuni & Purcal 2018; Dadashi 2019; Foziah et al. 2018; Halvorsen & Pedersen 2018; van Bilsen & Linders 2019) that used deterministic mortality rate in annuity modeling.

There is also a substantial volume of published studies describing the role of interest rates in delivering precise annuity prices. These studies (Bravo, 2017; Peijnenburg et al., 2017; Bruszas et al., 2018; van Bilsen and Linders, 2019) employ the stochastic process to capture the interest rate fluctuations in the future. Meanwhile, there are still recent studies (Maurer et al., 2016; Bateman et al., 2017; Warshawsky, 2018; Feng and Yi, 2019) that utilize deterministic interest rates in their modeling. This might be due

to some reasons highlighted by Oliveira, Vidal Nunes, and Malcato (2014). First, the deterministic interest rate is the method that most researchers have used in the literature on annuity modeling. Second, the performance deterministic interest rate is as good as the stochastic counterpart in minimizing the interest rate risk in longer investment horizons. Third, the current stochastic approach, for instance, the Cox-Ingersoll Ross and Vasicek model, fails to fully capture the uncertainty of future interest rates due to the unobserved uncertainties that happened on market price. Furthermore, to obtain the most precise interest rate prediction, stochastic interest rate models must be calibrated with daily interest rate data, as has been conducted by Oliveira, Vidal Nunes, and Malcato (2014). Evidently, it makes no sense for just minimum difference compared to the deterministic approach in the long run.

Affordability and product design are the key focus for many inflation-protected retirement products. Fung et al. (2019) discussed the construction of an inflation-indexed annuity, which, they noted, would insulate the retiree against the risk of inflation, ensuring consistent lifetime income. The study adopted a stochastic approach in modeling the fluctuation of interest rates. It demonstrated that inflation-protected annuity products could be more responsive to future economic uncertainties than fixed-rate products. However, the authors stated that these models require cumbersome calibration and can be sensitive to market volatility. For this reason, simpler deterministic models may be more appropriate under certain conditions.

As a result of the high fluctuation in inflation rates and the scarcity of traditional annuity products in Malaysia, recent studies have favored the introduction of IILAs. According to Holzmann (2020), inflation-indexed products should work particularly well in markets where inflation rates have been very volatile. The author advocated for deferred annuities and indexed products that move in step with economic indicators to help retirees maintain purchasing power over time. The key message from Holzmann's study was that such annuities could be affordable and accessible only in partnership with regulators and financial institutions in most emerging markets, where retirement income arrangements were underdeveloped.

Another recent paper by Asmuni and Purcal (2021) has analyzed how well Shariah-compliant annuity products can support the single country of Muslim retirees in Malaysia. This study again investigated the issues that in 2001 had caused annuity providers to suspend Shariah-compliant annuities and identified a number of those issues as still being prevalent, including underdevelopment of the Shariah bond market and high longevity risk. Hence, to overcome such hurdles, Asmuni and Purcal alternatively proposed methods of investment strategies that include diversified Shariah-compliant investment portfolios outside of bonds in other asset classes. This approach may reduce the longevity risk of annuities and have the potential to support the re-introduction of Shariah-compliant DC annuity products.

Recent literature has also centered on self-annuitization as an alternative to formal annuitization. Bravo (2021) investigated the possibility of self-annuitization, where retirees personally draw down funds from their investment portfolios. The author demonstrated that, though self-annuitization may work for very wealthy retirees who are able and willing to accept the attendant risks, it really does not address systematic longevity risk. This paper now reaches a similar conclusion: although self-annuitization may work for the select few retiree households that possess the necessary knowledge and means, most retirees will fare better with structured products offering annuitization.

Meanwhile, other authors, such as Bateman et al. (2022), discussed retirees' choice between annuities and self-annuitization from the perspective of behavioral factors in their decision-making. Having conducted a survey among retirees in Australia, the authors came to the following conclusion: the more financially literate retired people are, the more they value protection provided by these products against lifetime ruin, and hence, they are more likely to choose annuities. Furthermore, those who know little about finance prefer self-annuitization and tend to underestimate their longevity risk. Improved financial education, Bateman et al. believed, may lead to better retirement income decisions, particularly in markets where annuities are available but not utilized. On the various ways of modeling annuity, Oliveira et al. (2023) explored the applicability of both deterministic and stochastic interest rate models in view of annuity pricing. Their conclusion highlighted that while theoretically, the stochastic model offers better projection results, deterministic models may present results with enough precision but are much less complex and often more applicable for smaller markets. As such, their findings have vital implications for the selection of the modeling approach according to market size and data availability.

## METHODOLOGY

### The Wealth Process

In the accumulation phase of the DC, two elements are considered: basic elements and optional elements. The calculation of accumulated savings in the DC is based on the theory of future value. The following elements are required to approximate accumulated savings in the DC at the beginning of the retirement year: annual contribution rate (employee plus employer), annual dividend rate, annual salary, and total working years. Consider a basic DC which does not allow pre-retirement withdrawals from the employee. The accumulated savings in the DC projected to the beginning of the retirement year derived by Alaudin et al. (2016) is,

$$G_t = k \sum_{j=0}^{t-1} S(j) i \prod_{s=0}^{t-j-1} (1 + q_{s+j}), \quad (1)$$

where  $G_t$  is the accumulated savings in the DC,  $k$  is the contribution rate, which is a proportion of salary. Meanwhile,  $S(j)$  is the annual salary at year  $j$ ,  $i$  is the salary increment,  $q_{s+j}$  is the dividend rate at year  $s + j$ , and  $t$  is the total working years. If the yearly salaries are unavailable, the salaries can be approximated using  $S(j) = S(0) \prod_{s=0}^{j-1} (1 + i_s)$ , where  $S(0)$  is the starting salary, and  $i_s$  is the salary increment rate at year  $s$ .

Suppose contributors of the DC have one pre-retirement withdrawal (for house purchase, education fee, hospital fee, personal use, or other uses). In that case, the accumulated savings in the DC is equal to the accumulated savings in the DC in (1) minus the accumulated pre-retirement withdrawal:

$$G_T = k \sum_{j=0}^{t-1} iS(j) \prod_{s=0}^{t-j-1} (1 + q_{s+j}) - pk \left[ \sum_{j=0}^{t_i-1} iS(j) \prod_{s=0}^{t_i-j-1} (1 + q_{s+j}) \right] \prod_{j=t_i}^{t-1} (1 + q_j), \quad (2)$$

where  $p$  is the percentage of pre-retirement withdrawal, and  $t$  is the number of years from withdrawal year to retirement year. With some modifications, similar equations can be obtained if we have two or more pre-retirement withdrawals.

### The Mortality Risk

With the assumption of time of death,  $D$  of individuals follow uniform distribution (continuous) that is deterministically distributed and let  $\lambda(t)$  be the mortality rate of a population's cohort. Let the initial value of mortality be  $\lambda_0 = \lambda(0)$ . Thus, in the deterministic framework developed by Huang et al. (2012), the survival probability from time  $t$  to time  $s$  is given by

$$\begin{aligned} p(t, \lambda_0) &= e^{-\int_t^s \lambda(s) ds}, \\ &= \frac{p(s, \lambda_0)}{p(t, \lambda_0)}, \end{aligned}$$

where under standard Gompertz model,  $\lambda(t)$  is denoted as,

$$\lambda(t) = \frac{1}{b} e^{\left(\frac{x+t-m}{b}\right)},$$

where  $m$  is the modal of death,  $b$  is the dispersion coefficient of the standard Gompertz model, and  $x$  is the individual's age at time 0 estimated from Abridge Life Tables 2018 provided by the Department of Statistic Malaysia (DOSM).

### The Pricing and Benefits of Life Annuity

This study uses the life annuity pricing and benefit model developed by Gupta and Li (2007) and Lazar (2007). The model developed by Gupta and Li (2007) is a basic model that comprises fundamental elements, such as mortality rate, premium, risk-free return rate, annuity fees, and annuity return rate. Meanwhile, Lazar (2007) proposed a type of life annuity with benefits linked to the consumer price index, namely an Inflation-Indexed Life Annuity (IILA). Following Gupta and Li (2007) and with the addition of inflation linked to the benefit as used by Lazar (2007), the price of a Deferred Life Annuity (DLA) purchased by a person at age  $x$  with the time of annuitization  $T_s$  is,

$$a_x^{T_s, T_D} = \sum_{i=0}^{T_D - T_s + 1} \left[ \frac{B_i \cdot i P_x}{\prod_{j=1}^{i-1} R^j (1 + F_{j/(j-1)})} \right],$$

where  $R = (1 + r)$ ,  $r$  is the nominal interest rate, and  $T_D$  is the maximum expected life span. Meanwhile,  $T_S$  is the age of purchasing an annuity,  $x$  is the age of the annuitant,  $B_i$  is the annuity benefit at the time  $i$ ,  ${}_iP_x$  is the probability that retirees with age  $x$  survive to  $i$  year based on the Gompertz model,  $F_{j/(j-1)}$  be the annual inflation rate for time  $j$  and can be solved in the framework of the consumer price index at time  $j$ , denoted as  $CPI_j$  is modeled as follows,

$$F_{j/(j-1)} = \frac{CPI_j}{CPI_{j-1} - 1}.$$

The pricing of IILA can be modeled as,

$$a_x^{T_D} = \sum_{i=h}^{T_D-1} \left[ \frac{B_i \cdot {}_iP_x}{\left[ \prod_{j=1}^{i-1} R^j (1 + F_{j/(j-1)}) \right]} \right].$$

Here,  $h$  is the time of annuitization. In the case of  $h = 0$ , the equation refers to IILA. If  $h \geq 1$ , then the equation refers to dIILA. The benefit payment for the IILA that will be adjusted to inflation at time  $i$  denoted as  $B_i$ , is modeled as follows,

$$B_i = B_{i-1} \max(1; 1 + F_{j/(j-1)}).$$

Meanwhile, the benefit payment for dIILA at time  $i$  denoted as  $B_i$ , is modeled as follows,

$$B_i = B_{i-1} I_i \cdot \max(1; 1 + F_{j/(j-1)}).$$

Note that  $V_i$  is an indicator function for the benefit which states that,

$$I_i = \begin{cases} 0 & i < T_S \text{ or } i > T_D \\ 1 & i = T_S, \\ \prod_{s=T_S}^{i-1} \frac{R_s^u - M}{R^j} & T_D \geq i > T_S. \end{cases}.$$

Where  $R_s^u$  is the return of underlying investment during the deferment period, and  $M$  is the annuity fees during retirement years.

## Optimization Model

This study used the optimization model by Chen et al. (2018),

$$V = \max_c \sum_{i=k}^{T_D-T_S+1} \delta(i) \cdot {}_iP_x \cdot u(c_{x+i}),$$

subject to

$$\sum_{i=0}^{d-1} c_{x+i} \cdot v^i + \sum_{i=d}^{T_D-T_S+1} c_{x+i} \cdot v^i \cdot {}_iP_x \cdot (1+M) = 1,$$

where  $\delta(i)$  is the subjective discount function for utility,  $d$  is the number of deferred years,  $u(c_x) = \frac{c_x^{1-\gamma}}{1-\gamma}$  is the utility function,  $\gamma$  is the utility parameter,  $v^i = (1+r)^{-i}$  is the discount rate. Using the Euler-Lagrange method, we have the optimal allocation  $\alpha$ , in purchasing dHILA.

$$\alpha = \frac{(1+M)^{\left(1-\frac{1}{\gamma}\right)} \cdot \sum_{i=d}^{T_D-T_S+1} (1+r)^{-i} \cdot {}_iP_x}{\sum_{i=0}^{d-1} (1+r)^{-i} \cdot {}_iP_x^{1/\gamma} + (1+M)^{\left(1-\frac{1}{\gamma}\right)} \cdot \sum_{i=d}^{T_D-T_S+1} (1+r)^{-i} \cdot {}_iP_x}$$

## RESULTS AND DISCUSSIONS

We consider two scenarios for our numerical examples:

- i. Scenario 1 – A small-scale analysis that considers an individual (a household head) from the HEIS14 and HES09 samples.
- ii. Scenario 2 – A large-scale analysis that considers all household heads in the HEIS14 and HES09 samples.

### Scenario 1

As an alternative to the existing withdrawal system by the DC, we proposed a type of widely employed withdrawal in DC pension plans worldwide, which is the purchase of life annuities. The rationale behind this is mainly to minimize the probability of financial retirement ruin, which is a condition where the retirees run out of wealth before death. Compared to lump-sum withdrawal or programmed withdrawal, which allows retirees to withdraw the money according to their wills, annuitization offers a fixed amount of money to withdraw. However, one issue that may arise is the adequacy of the annuity income to their retirement consumptions.

In this sub-section, we discuss details on retirees' attributes such as comprise final salary prior to retirement, expected retirement consumptions, accumulated savings in the DC, annuity income from immediate and deferred life annuities, expected length of retirement, and retirement income for the case that retirees opted to not commit to the annuity. As provided in Table 1, we have three male retirees with different attributes and scenarios with Immediate Life Annuity (ILA) and five-year DLA.

**Table 1**

*Sample of Retirees' Attribute from HEIS14*

<b>Retiree</b>	<b>Final Salary (RM)</b>	<b>Expected Retirement Time</b>	<b>Accumulated DC (RM)</b>	<b>ILA (RM)</b>	<b>dILA (RM)</b>	<b>Expected Monthly Consumption (RM)</b>
<b>A</b>	4846.47	24.8	478049.40	2518.31	1795.03	3392.53
<b>B</b>	3032.77	16.4	293996.10	1548.73	1103.92	2122.94
<b>C</b>	11923.46	24.9	1155724.00	6088.21	4339.62	8346.42

**Table 2**

*Replacement Rate for IILA and dIILA*

<b>Case</b>	<b>Replacement rate (%)</b>	
	<b>IILA</b>	<b>dIILA</b>
<b>A</b>	52	37
<b>B</b>	51	36
<b>C</b>	51	36

**Table 3**

*Sample of Retirees' Attribute from HES09*

<b>Retiree</b>	<b>Final Salary (RM)</b>	<b>Expected Retirement Time</b>	<b>Accumulated DC (RM)</b>	<b>IILA (RM)</b>	<b>dIILA (RM)</b>	<b>Expected Monthly Consumption (RM)</b>
<b>2D</b>	3125.68	23.6	305262.50	1485.10	1169.10	2187.97
<b>4E</b>	5522.64	16.2	534640.20	2601.04	2047.56	3865.85
<b>6F</b>	19595.59	20	1913058.00	9307.07	7326.62	13716.91

**Table 4**

*Replacement Rate for IILA and dIILA*

<b>Case</b>	<b>Replacement rate (%)</b>	
	<b>IILA</b>	<b>dIILA</b>
<b>D</b>	48	37
<b>E</b>	47	37
<b>F</b>	47	37

We selected the sample in Table 1 since they represent the three classes of income, which are poor households in the Bottom 40 (B40) group, middle-income households in the Middle 40 (M40) group, and rich households in the Top 20 (T20) group. Households are considered B40 if household income is less than RM4360, M40 if household income is between RM4360 and RM9619, and T20 if household income is more than RM9619 (DOSM, 2016).

With the final salary of RM4,846.47, Retiree A is expected to accumulative savings in DC of RM474,140.50 based on the assumption that the three pre-retirement withdrawals were made. This accumulated savings in the DC will create a monthly retirement income from the IILA of RM2,576.77. With an expected retirement consumption of 70% of the final salary, Retiree A is expected to consume RM3,392.53 per month, leading to insufficient retirement income, as none of the IILA and DLA can provide a lifetime retirement income greater than the expected consumption.

In case Retiree A decides to have self-annuitization (accumulated savings in the DC divided by the expected retirement time in a month), the expected retirement income is lower than that of IILA and DLA, which is RM1936.85. Thus, the best option for Retiree A is to purchase an IILA or DLA to prevent

financial ruin if his survival time is beyond 20.4 years. However, the estimated final salary before retirement can only be replaced by 53% and 46% for ILA and DLA, respectively.

Compared to Retiree A, who represents the M40 household, Retiree B, who represents the B40 household, has lower income and lower accumulative savings in DC, which resulted in lower and inadequate ILA and DLA. Retiree B is expected to consume RM2122.94 per month throughout retirement years with the assumption that the retirement consumption is 70% of the final salary. Even if households have higher final salaries, such as those of Retiree C, ILA and DLA are still unable to provide adequate retirement income, as indicated in Table 2.

Overall, it has been evidenced that Retiree C has the most benefit from a life annuity. This might be due to several reasons. First, Retiree C has a higher accumulation of savings in DC, which can produce higher annuity income. Second, Retiree C has higher expected retirement years. For this reason, Retiree C will receive the annuity income longer. As more individuals like Retiree C opt to purchase a life annuity, the issue of adverse selection may arise. In brief, adverse selection is a situation where the annuity is purchased by individuals with long life expectancies. In the long run, the adverse selection may increase the price of a life annuity, resulting in a high premium charged. Therefore, to mitigate the risk of adverse selection, the annuity provider should only provide life annuity to selected groups, for instance, households that have social economics like Retiree B.

## **Scenario 2**

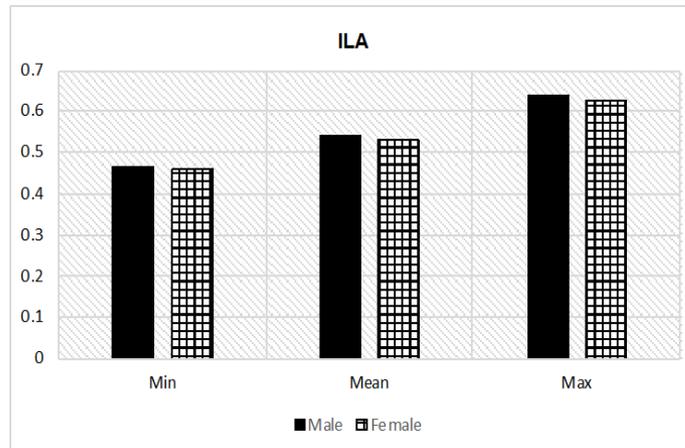
The analysis for Scenario 2 is to examine the adequacy of the ILA and DLA to the expected retirement consumption based on the assumed replacement rate among the 6,642 households. We consider this sample after filtration based on age (age 24-60), occupational group (where we choose only private-sector workers contributing to DC), and a minimum monthly salary of more than RM1200, which is the minimum monthly salary in Malaysia (DOSM, 2019).

We then compare the annuity income by ILA and DLA with the assumed retirement consumption, for instance, 70% of the final salary before retirement. This ratio is considered appropriate (Alaudin *et al.* 2017; Kamal *et al.* 2019) after considering some reductions in the work-related expenses defined by Aguiar and Hurst (2013) that include the expenses for clothing and footwear, transport, and expenses on restaurants and hotels. Generally, expenses on clothing and footwear are high only during working years, and retirees will spend less on these items. Furthermore, retirees will not have a daily commute to the workplace after retirement. Hence, we also assumed that this expense would be reduced. Conclusively, with the amount of time at home increasing, retirees tend to have more time to do groceries and cook for themselves, which has resulted in a reduction of expenses for restaurants and hotels.

Figure 1 displays the income ratio from ILA to the last salary before retirement. Meanwhile, Figure 2 illustrates the ratio of income from DLA based on five deferment years to the last salary before retirement. Both ILA and DLA fail to provide at least 70% of retirees' final salary before retirement. Even if full annuitization is at the beginning of the retirement year, ILA can only provide the maximum lifetime income of about 64% (63%) of the final salary for male (female) retirees. Also, with a five-year deferment, DLA can only provide the maximum lifetime income of about 55% (53%) of the final salary for male (female) retirees. Hence, the longer the deferment years (see Figure 3), the less income from DLA due to lower optimal allocation for annuities.

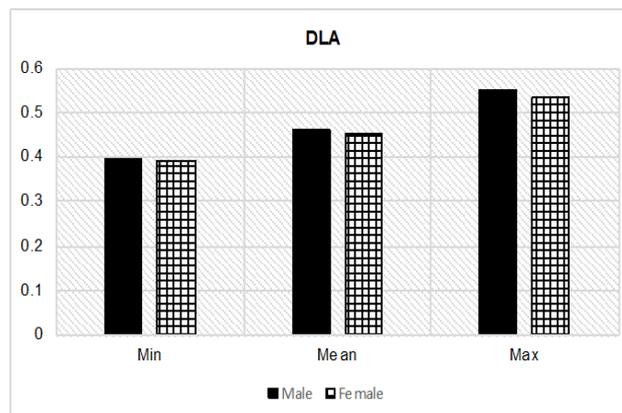
**Figure 1**

*Ratio of income from ILA to the last salary before retirement*



**Figure 2**

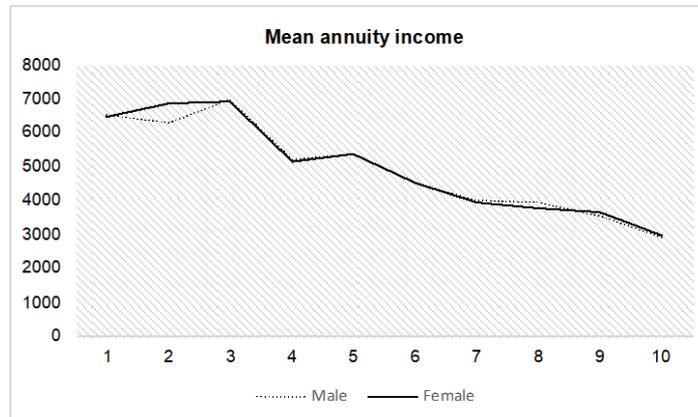
*Ratio of income from DLA to the last salary before retirement*



In the case of retirees who prefer to purchase a DLA, it is suggested that they have three years of deferment with an optimal allocation for purchasing a life annuity, which is 72% for both males and females. The results are provided in Figure 3, where the annuity payment is the highest when the purchase is deferred for three years and the lowest when the deferment is ten years. In addition to deferment years, Figure 4 displays the decrement of optimal allocation in purchasing DLA for both male and female retirees.

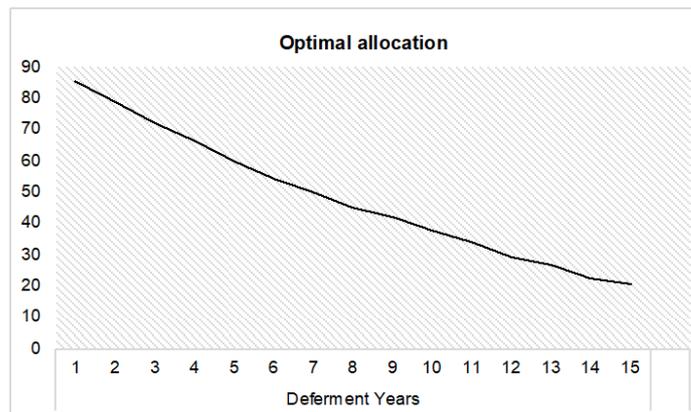
**Figure 3**

*Mean annuity income from DLA based on the deferment years*



**Figure 4**

*Optimal allocation for purchasing DLA*



With a minimum lifetime income for both male and female retirees, about 46% (40%) for ILA (DLA), purchasing a life annuity at retirement is unsuitable for every retiree for several reasons. First, not every retiree can accumulate decent retirement wealth since there are several households (175 households) that are still confined with a monthly income below RM4,000, which indirectly contributed to the low accumulated savings in the DC. This situation is also worsened by the variety of pre-retirement withdrawals made in the accumulation phase, for which this study assumed three pre-retirement withdrawals are made. In real situations, DC members tend to withdraw their accumulated savings in the DC for various reasons, for instance. Thus, their accumulated savings in the DC becomes very low. Second, full-annuitization is unsuitable for retirees who are expected not to have long-term retirement years. In other words, retirees with average or minimum life expectancies have better retirement incomes if they opt to have scheduled withdrawals with strict discipline.

Meanwhile, to finance the expenses between the time retirement year and the annuity payment year, retirees may use the balance of their accumulated savings in DC, which is 28%, through strict self-

annuitization. Several self-annuitization methods can be used, for instance, the optimal withdrawal rate by Huang, Milevsky and Salisbury (2012), the sustainable withdrawal rate by Huang, Milevsky and Wang (2004), or even the traditional replacement.

Considering the accumulated savings in the DC without annuitization, retirees are expected to withdraw the money based on the monthly consumptions with 70% of the final salary. Using this monthly consumption, the accumulated savings in the DC is expected to last mostly between 8.9 to 16.5 years for both males and females, as displayed in Figure 1 and Figure 2. Theoretically, accumulated savings in the DC can provide a constant yet enough withdrawal rate for at least 8.9 years of retirement. However, due to the inefficiency of the DC system that allows lump-sum withdrawal and poor attitude toward consumption among retirees, most of them run out of their DC way earlier than expected. In the case that the replacement rate is reduced by 20%, 30%, 40%, and 50%, respectively, there is an increase in several years before wealth depletion, as summarized in Table 3.

**Table 3**

*Years before wealth depletion for HEIS14*

Summary	Replacement Rate (%)							
	80		70		60		50	
	M	F	M	F	M	F	M	F
<b>Min</b>	8.9	8.9	10.1	10.2	11.8	11.9	14.2	14.3
<b>Median</b>	10.1	10.1	11.6	11.6	13.6	13.6	16.3	16.3
<b>Mean</b>	10.3	10.3	14	11.8	13.8	13.7	16.5	16.5

### **Comparison of the 60% pension income**

Along with the United States of America, France, Argentina, Ukraine, and India, Malaysia's pension system also consists of both DC and DB pension plans. However, Civil Pension (CP), as the proxy of the DB pension plan in Malaysia, can only be provided to permanent government employees, who make up only 1.7 million of a total population of 32 million. The benefits provided by the CP to the pensioners include a lifetime monthly pension, cash award in place of accumulated leave, gratuity, and some other benefits to the dependents due to the death of pensioners or the death of a government employee in service.

With a variety of retirement benefits provided by the CP, this study is unable to make a head-to-head comparison between the DC and the CP. Despite that, the feature that can still be compared is retirement income from the DC with ILA to the lifetime pension income by the CP. For pensioners with CP, the lifetime pension income is subject to some factors, which include several months in service and the last drawn salary before retirement, as stated by the Public Service Department (PSD) Malaysia.

Compared to the retirement income from ILA purchased from the accumulated savings in the DC, the lifetime pension income is subjected to a maximum pension of 60% of the last salary drawn. Disregarding other benefits provided by the CP, the ILA can provide higher monthly retirement income than the CP's (see Figure 1 and Figure 2), where the maximum replacement rate by ILA exceeded the 60% benchmark. However, this result is restricted to the limitation that the retirees have only had the three most common pre-retirement withdrawals, which resulted in a lower outflow of money and higher accumulated savings in the DC at the moment of retirement. With 17 pre-retirement withdrawals offered by the DC, we have challenges applying other types of withdrawals. This study believes that by having the actual data on an individual's pre-retirement withdrawals, a better estimation of accumulated savings in the DC can be achieved.

## **CONCLUSION**

We proposed a life annuity withdrawal system as an alternative to the lump-sum withdrawal system. To be precise, we implement two types of life annuities, namely ILA and DLA, with optimal asset allocation using optimization of the Euler-Lagrange method. The retirement incomes from ILA and DLA are then compared to the assumed consumption of working years.

The results reveal that ILA and DLA are unable to meet the expected retirement consumption, which is assumed to be 70% of the final salary before retirement. In Scenario 1, we prove retirees are better off with the purchase of ILA or DLA than opting for self-annuitization. Even though ILA and DLA provide lower income versus the expected consumption, both ILA and DLA can provide lifetime income. Thus, retirees will not encounter the probability of financial retirement ruin. In Scenario 2, we examine the adequacy of the ILA and DLA to the expected retirement consumption based on the assumed replacement rate (70%) among 6,642 households. Both ILA and DLA fail to provide at least 70% of retirees' final salary before retirement. In case of full annuitization at the beginning of the retirement year, ILA can only provide the maximum lifetime income of about 64% (63%) of the final salary for male (female) retirees.

Overall, even though retirees may receive low retirement income, they can always make a minor adjustment to their consumption throughout the retirement years by removing other non-basic expenses. Thus, we conclude that the annuity-based withdrawal system is suitable for replacing the existing withdrawal system in the DC pension plan in some countries. Furthermore, this study also proves that the current DC pension plan is efficient in accumulating retirement income for its members. However, the problem of having low accumulated savings in the DC is due to various pre-retirement withdrawals made throughout the accumulation years.

## **CONFLICT OF INTEREST**

The authors declare that they have no conflict of interest.

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