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The Appropriateness of Fixed and Lifecycle Asset Allocations as Default Investment Choices for Defined Contribution Plans

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ABSTRACT

This paper studies the default investment choices in the context of the Thailand Government Pension Fund (GPF), a mandatory defined contribution (DC) plan for Thai public servants. Using a simulation method, we assess the appropriateness of various balanced asset allocation strategies, from conservative to aggressive and from fixed to "lifecycle" allocations, as a default plan. We find that aggressive strategies that allocate higher portfolio weights to equities outperform a more conservative strategy both in terms of upside potential of exceeding certain target portfolio returns, and downside risk of falling below that target returns. We also find that fixed asset allocation strategies outperform comparable lifecycle strategies. However, when there is an equity market crash near retirement, the relative performance between fixed and lifecycle strategies is reversed. Since the objective of the DC plan is to meet a certain target portfolio return coupled with inertia behaviors on the part of plan members, our findings suggest the appropriateness of a lifecycle asset allocation as a default plan.

JEL Classification: D92, E22, G31

Keywords: Defined Contribution, Asset Allocations, Default Investment Plan, Balanced Funds, Lifecycle Investment

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BACKGROUND AND MOTIVATION

Any official who enters the Thai government service after March 1997 is required to be a contributing member of the Government Pension Fund (GPF), which is a mandatory defined contribution (DC) scheme. Each month, members and the government make regular payments into an individual account; the money is then invested and managed by the GPF. At retirement, members will receive the amounts plus any investment return on the money in the account. The retirement benefit from the GPF is supposed to partially substitute pension payments from the old defined benefit scheme, which has been reduced by at least 30% under the new law. As with other DC plans, the benefit from the GPF is subject to investment risk and return. To provide some degree of control over their own savings, the GPF offers five investment options from which members can choose. These choices are defined in terms of their asset class allocation strategies. If members fail to make a choice, their accounts are assigned to the core or default investment plan. Although the default plan is structured to be a balanced fund, the strategy is rather conservative for a long-term investment, especially for retirement, as portfolio weights on equity securities are limited to no more than 30%. Interestingly, around 98% of GPF's assets are invested in the default plan.

Default plans do offer some advantages by simplifying the investment decision making process, especially, for plan members who have little or no financial knowledge. It has been found in many countries that most DC plan assets are invested in default plans[1]. However, empirical evidence suggests that default options are not active choices made by plan members. For example, Beshears *et al.* (2006) study the US 401(k) plans and find that members in DC plans tend to enroll in default plans because they perceive default options as a recommendation or an endorsement from the plan sponsors or from the plan providers about the appropriateness of the plans. Given that investment outcomes from default plans affect a large proportion of DC plan participants who opt to be in the plan passively, it is important that portfolio strategies of default plans are appropriately designed to allow a broad group of plan participants to meet their saving targets.

Existing research on the appropriateness of default plans mainly focuses on DC plans in developed countries, for example, Basu and Drew (2009, 2010), Pang et al, (2008), Poterba *et al.* (2006), and Schleef and Eisinger (2007). However, the issue of whether DC plans will provide sufficient retirement income is even more critical in less developed countries, such as Thailand, where the social welfare system is not as well-established. In this study, the appropriateness of the GPF's default investment plan is examined. Although Kunara and Pfau (2011) investigate this issue in the context of emerging market countries, their study is based on hypothetical portfolios. Our study, on the other hand, is based on an actual pension fund.

Since its inception in 1997, the issue of whether the GPF's default plan has been appropriately designed has never been investigated in the literature. We intend to fill this gap and offer competing candidates for default options. Given the impact that the GPF could have on the sustainability of Thailand's pension system[2], this issue warrants an academic research. The

[1] See Choi *et al*. (2003) for US, Bridgeland (2002) for UK, Cronqvist and Thaler (2004) for Sweden and IOPS (2012) for international evidence.

[2] As of 2015, GPF manages more than 1.2 million member accounts. Its assets under management stood at 714 billion Baht. GPF has now become one of the country's largest institutional investors in Thailand, second only to the Social Security Fund. See www.gpf.or.th/download/annual/Gpf2557.pdf

rest of this paper is organized as follows. Next section reviews the extant literature pertaining to default investment plans in defined contribution schemes. Further sections describes the methodology and sources of data used in this study, and reports the results and discussion. Finally, the last section concludes the paper.

LITERATURE REVIEW AND RESEARCH OBJECTIVES

Portfolio returns can be driven by different steps in the portfolio construction process, which includes asset class allocation, security selection, and market timing. Brinson *et al.* (1986) demonstrate that asset allocation strategy influences most parts of the portfolio returns. In this paper, we will investigate various asset allocation strategies, including the current default option, to assess their appropriateness as a default plan for retirement investment in the context of the GPF. Since the GPF clearly defines its investment objective as to provide long-term returns in excess of long-term inflation, we will assess appropriateness of an investment strategy from the probability of that strategy to meet the target returns[3].

The default option offered by the GPF is a balanced fund investing no more than 30% of portfolio weights on equities and no less than 60% on safe assets. Based on an international survey by IOPS (2012), balanced investment is a popular strategy adopted by DC plans as default options because this strategy provides diversification benefits. In practice, the degrees of portfolio weights assigned to equities could be different across plan providers, resulting in different degrees of expected return and risk. There is no consensus in the literature as to what constitutes the optimal balance between various classes of assets. Basu and Drew (2010) define risk as the chance of missing the return target. They find that portfolios that assign more weights to equities tend to outperform portfolios that are more conservative from both upside gain and downside risk perspectives. Their results imply that in a long-term investment, such as retirement saving, high risk premium on equity tends to outweigh its risk. However, Pang and Warshawsky (2008) argue that a high weight on equity leaves plan members vulnerable to losses, especially when retirement approaches.

Over the past decade, an investment strategy known as "lifecycle" or "target date" has gained tremendous popularity as the default plan in mandatory DC funds in many countries[4]. In the US, assets managed under the target date plans have grown significantly since it was first introduced in 1994. At the end of 2014, assets managed under the target date plans exceeded $700 billion, representing around 8% of the total mutual fund assets (Morningstar, 2015). A lifecycle strategy is essentially a balanced fund with time-varying asset allocations. The strategy initially allocates a high proportion of a member's account to equities when the member is young and has a long investment horizon, in order to enjoy a high return potential. As the member becomes older, portfolio weights on equities are gradually reduced with a predetermined glide path and replaced by safer assets, in order to provide the member with a higher degree of income stability when the investment horizon comes closer. The lifecycle strategy is designed to overcome inertia behavior of pension members who fail to actively choose suitable strategies and to rebalance portfolios when ability to take risk diminishes with a decrease in investment horizon.

[3] In this paper, we test the appropriateness of a default strategy against actual target investment outcomes. Previous studies either test the appropriateness issues without comparing with target outcomes, such as Bridges *et al.* (2010) and Pang and Warshawsky (2008), or against a hypothetical target outcome assumed by the authors, such as Basu and Drew (2010).
[4] See IOPS (2012)

Lifecycle plans have only recently started gaining recognition in the Thai investment community[5]. In 2013, the GPF was the first fund provider to offer a lifecycle plan as one of the investment choices for fund participants. Since then, debate has risen among practitioners and academia on whether the existing fixed allocation strategy should be replaced by the lifecycle strategy as a new default plan. However, the lifecycle plan is not without criticism. Some studies argue that lifecycle strategies assign high equity weights when accumulated contribution is low, but the weights on equities are reduced when accumulated contribution becomes large (i.e., as members become older). This practice means that plan members will lose the opportunity to earn higher risk premium on equity when the total investment sum is high. Basu and Drew (2009), Schleef and Eisinger (2007), and Pang and Warshawsky (2008) suggest that lifecycle allocation tends to underperform fixed asset allocation strategies even when average asset allocations over the investment horizon are the same. However, Poterba *et al.* (2006) and Pfau (2010) use expected utility to measure investment outcomes and find that, for risk averse investors, lifecycle investment could produce higher expected utility than comparable fixed allocation strategies.

To evaluate whether a specific investment strategy is appropriate as a default choice for a DC plan, the ability of the strategy to achieve the plan's goals must be assessed. It is arguable that the main objective of retirement savings is to ensure a sufficient level of income after retirement. To this end, the performance of DC plans should be measured in terms of their ability to generate sufficient retirement income (Baker *et al.*, 2005). However, the GPF is designed to be an add-on retirement income that complements the old defined benefit scheme, and the fund clearly states its objective as to generate positive real return in the long-run. Therefore, the relevant measure of investment outcomes in our study is portfolio internal rate of return (IRR).

Extant research mainly employs portfolio terminal value[6], replacement ratio[7], or expected utility[8]. However, unlike portfolio terminal value and replacement ratio, IRR does not depend on contribution rates and unlike expected utility, IRR does not depend on other sources of income. Both contribution rates and other sources of income are out of the control of the plan providers. The use of IRR allows us to focus on only the effect of asset allocation strategies[9] and it is consistent with the GPF's investment objective, which is defined in terms of portfolio return.

We use information from GPF's investment policy statement to set a target for portfolio return. Since the policy statement is publicly available, it is likely that plan members adopt this target as a common investment goal. Furthermore, we view the main objective of a DC pension fund as to ensure the sufficiency of retirement income. In other words, we assume that GPF's main objective is to minimize the chance that the actual portfolio will be less than the target level (i.e., shortfall risk). Therefore, we will follow Basu and Drew (2010) and focus on the downside risk.

[5] Lifecycle strategy is known as Life path strategy in Thailand.
[6] For example, Basu and Drew (2009, 2010), Pang and Warshawsky (2008), and Schleef and Eisinger (2007).
[7] For example, Byrne *et al*. (2007).
[8] For example, Pfau (2010) and Poterba *et al*. (2006).
[9] Bridges *et al.* (2010) also employ IRR on investment to capture investment outcomes.

DATA AND METHODOLOGY

To analyze the appropriateness of various asset allocation strategies, we consider a hypothetical public servant who starts working at the age of 20 and earns THB15,000 per month. Her salary rises 2% semiannually until she retires at the age of 60. Each month, the combined contribution of 8% is accumulated to her GPF account. There is no withdrawal/redemption from the account before retirement. Investment outcomes from different strategies will be tracked until the member is 60 years old, resulting in 40 years of investment period. Terminal dollar outcomes and the corresponding implied IRRs would be compared across strategies.

Asset Allocation Strategies (Member Investment Choices)

According to information provided in the annual report 2015, GPF classifies assets into 4 groups, namely, safety, diversifying, inflation sensitive, and growth assets. Assets are then further divided into 17 classes, such as, Thai government bonds, Thai corporate bonds, World corporate bonds, Thai equity markets, Developed equity markets, etc. In this paper, we will simplify the asset classification to include only 4 classes[10], namely, Short-term Thai government bonds (SGB), Thai government bonds (TGB), Thai equity market (TEQ), and Developed equity markets (WEQ). Table 1 shows the asset classes and their proxies used in this study.

Table 1: Asset Classes and Their Proxies

Asset Class	Symbol	Description
Short-term Thai government bonds	SGB	Thai BMA 1-3 Years Thai Government Bond Index
Thai government bonds	TGB	Thai BMA 1-10 Years Thai Government Bond Index
Thai equity	TEQ	SET TR Index
Developed market equity	WEQ	MSCI World TR Index

Five asset allocation strategies are constructed as candidates for a default plan. Two strategies, namely, the "Default" and the "Lifecycle" plans are based on existing investment choices offered by GPF. Asset allocation policies for these plans are publicly available[11]. We make some adjustments such that portfolio weights can be assigned to the four asset classes described in Table 1, while keeping the strategies as close as possible to the actual policies. The default plan is a balanced fund with fixed asset class allocation over time where the weight on equities is no more than 30%. The Lifecycle plan is a time-varying asset allocation.

Existing evidence shows that aggressive investment strategies tend to give better outcomes for long-term investment due to higher risk premium from equities compared to fixed income securities. Furthermore, a fixed allocation strategy based on average portfolio weights of a lifecycle plan may provide better investment performance than the lifecycle plan (Basu and

[10] Although this may seem to be oversimplified, there are few reasons why we choose to include only 4 asset classes rather than 17 classes used by GPF. First, the policy weights on many assets are very low (less than 5%), for example, Infrastructure, Commodity, Absolute return funds, etc. Second, it is quite hard to identify reliable proxies for some asset classes, for example, Thai real estate and Thai corporate bonds. The four asset classes we used should be able to capture at least 70-80% of the actual portfolio.

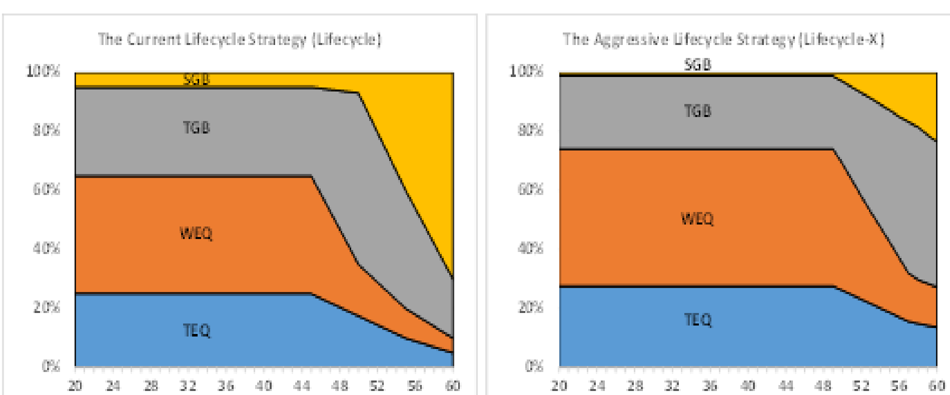
[11] GPF's Investment Choices (www.gpf.or.th/download/general/mic.pdf).

Drew, 2009). This is because lifecycle plans assign more weights on equity when plan members are young and hence have low accumulated contribution. As members get older and have more accumulated contribution, the portfolio weights start shifting away from equities to low risk assets. Therefore, the plan members lose out the opportunity to capture higher risk premiums from equities.

To examine these issues, three hypothetical plans are constructed. The first plan is the "Aggressive" investment strategy with fixed asset allocation. The portfolio weight for the Aggressive strategy is based on portfolio weights during the fixed weight period of the current Lifecycle plan, with around 65% on equities. The second plan is the "Moderate" investment strategy with fixed asset allocation. The asset allocation for the Moderate strategy is based on the average portfolio weights during a 40-year investment period of the current Lifecycle plan, with around 52% on equity. The last plan is the aggressive lifecycle strategy (Lifecycle-X), where portfolio weights on equities are higher and the shift toward safety assets starts later compared to the current Lifecycle. The time-varying asset allocation for Lifecycle-X is constructed in such a way that the average weights during the 40-year investment are equal to the portfolio weights of the Aggressive plan. The portfolio weights for the five competing strategies are reported in Table 2. Note that for "Lifecycle" and "Lifecycle-X", the table reports average weights over the 40-year investment horizon. The predetermined glide paths for Lifecycle and Lifecycle-X are shown in Figure 1.

Table 2: Portfolio Weights (w_i's) of Different Asset Allocation Strategies

	Default	**Moderate**	**Aggressive**	**Lifecycle[1]**	**Lifecycle-X[2]**
SGB	10%	15%	5%	15%	5%
TGB	60%	34%	30%	34%	30%
TEQ	15%	21%	25%	21%	25%
WEQ	15%	31%	40%	31%	40%



[1,2] The figures represent average portfolio weights over a 40-year investment horizon.

Figure 1: Glide Path for Lifecycle and Lifecycle-X Strategies

Simulation method for generating investment outcomes

Monthly return from each investment strategy *($R_{p,t}$)* is calculated as:

$$R_{p,t} = \sum_{i=1}^{N} w_{i,t} R_{i,t}$$

where $R_{p,t}$ = Real return on portfolio p during month t
$w_{i,t}$ = Portfolio weight assigned to asset i in month t
$R_{i,t}$ = Real monthly return on asset i in month t

To generate Ri,t, we employ the Monte Carlo simulation. The inputs to the simulation consisting of expected returns, standard deviation of returns, and return correlations. They are drawn from the historical distribution of asset returns under the assumption that returns are multivariate and normally distributed, and there is no serial correlation in asset returns. Monthly total return indexes for various asset classes and USD/THB exchange rates between January 1999 and December 2015 are collected from DataStream. To account for potential foreign exchange risk and diversification benefits, the index for WEQ is converted to THB[12] before return is calculated. The sample contains 17 years of monthly returns. The sampling period may be considered short given that we have to simulate returns 40 years ahead. However, data availability, especially on USD/THB exchange rate and Thai government bonds, confines us to this sampling period.

Table 3 reports the means and standard deviations of real returns (% pa.) on the four asset classes. As expected, average historical real returns and standard deviations of real returns are higher for equities than for government bonds. For equities, Thai market equities have historically produced a higher mean and standard deviation of real returns than developed market equities. This is consistent with the well-known fact that emerging market equities tend to have more growth opportunities but their returns are less stable compared to developed markets. For government bonds, long-term bonds have produced a higher mean and standard deviation of returns than short-term bonds. The historical returns shown in Table 3 generally reflect the risk/return tradeoff between equities and bonds. It is the higher risk premium in equities, especially, on Thai equities that could be the key to achieve the return objectives of a long-term investment.

Table 3: Historical Mean and Standard Deviation of Real Returns on Asset Classes

	SGB	TGB	TEQ	WEQ
$E[R_i]$	1.58%	2.45%	10.34%	6.16%
S.D. R_i]	2.80%	4.87%	25.13%	15.56%

Table 4 shows the historical correlation among the four asset classes. Apart from the correlation between long- and short-term government bonds, pairwise correlations are generally low across the asset classes. Correlation coefficients are negative between three pairs of assets,

[12] The USD-denominated return (R^{USD}) is converted into THB-denominated return (R^{THB}) using the following equation. $R^{THB} = (1+R^{USD}) \times (1+c) - 1$, where c is the rate of change in USD exchange rate measured as a number of THB per USD.

namely, between SGB and WEQ, TGB and TEQ, and TGB and WEQ. The correlation structure implies high potentials for diversification benefits.

Table 4: Historical Return Correlations across Asset Classes

	SGB	TGB	TEQ	WEQ
SGB	1			
LGB	0.88	1		
TEQ	0.01	-0.02	1	
WEQ	-0.09	-0.06	0.38	1

Wealth accumulated into the member's account is derived from two sources, monthly contribution (xSt) and investment return *($R_{p,t}$)*, and it is calculated as:

$$W_t = W_{t-1}\,(1+R_{p,t}) + xS_t$$

where
W_t = Portfolio value at the end of month t (assume $W_0 = 0$)
$R_{p,t}$ = Portfolio return during month t
x = contribution rate (assumed to be 8%)
S_t = Monthly salary for month t

The contribution rate is assumed to be equivalent to the current mandatory combined contribution rate of 8% (5% from the government and 3% from the member). The salary is assumed to grow at the real rate of 2% every six months in April and October of each year until retirement.

After the terminal wealth (W_T) is calculated, IRR over the investment horizon (480 months) is calculated by solving the following equation.

$$W_T = xS_1\,(1+IRR)^{T-1} + xS_2\,(1+IRR)^{T-2} + \ldots + xS_{T-1}\,(1+IRR)^{T-(T-1)} + xS_T$$

where
W_T = Portfolio value at the time of retirement
T = Investment period (480 months)

We conduct 10,000 trails to generate 10,000 different monthly return paths for each asset class over the 40-year investment horizon. After return paths of different assets are simulated, portfolio weights are applied to calculate monthly portfolio returns, which are then combined with monthly contribution to generate W_T's and corresponding IRRs for all five asset allocation strategies. This simulation produces a probability distribution of 10,000 W_T outcomes and corresponding IRRs for each of the five asset allocation strategies.

The global equity market crash in 2008 highlighted the need for pension fund members to monitor and adjust their asset allocation as the investment horizon approaches, especially, when portfolio weights on equities are still high near retirement. Many individuals who retired in 2008 failed to do so causing significant losses on their retirement accounts and retirement income (Impavido *et al.*, 2010). This is actually what "lifecycle" is designed for - to circumvent inertia behaviors of plan members by automatically adjusting portfolio weights away from equity and into fixed incomes as the members' retirement approaches.

To test how well lifecycle strategies reduce the negative impact of equity market crashes, we will run a separate test assuming that the hypothetical public servant experiences a global equity market crash when she is 57 years old. This age is chosen because the member in the aggressive fixed asset allocation is most vulnerable to an equity market crash when the crash occurs near retirement and we want to give the portfolio some time to recover. We use the data in 2008 with some adjustments to forecast asset returns during the crisis. Table 5 summarizes the asset returns used in the simulation to represent the year equity markets crashed. Note that during the subprime crisis, although equity performed badly, government fixed income securities performed well as money fled from equities to safer assets. We will assume that the crisis lasts for one year. Apart from the expected return at the age of 57 years, the other assumptions on asset returns are kept constant.

Table 5: Equity Market Shock Assumptions

	SGB	TGB	TEQ	WEQ
$E[R_i]$	15%	7.0%	-45%	-29%

Measures of investment performance

To evaluate performance of an investment strategy, both investment risk and return should be considered. In this study, we follow Basu and Drew (2010) and use the shortfall of IRR below target outcomes (rather than standard deviation of IRR) as a measure of risk. This is consistent with the investment objective of GPF to make positive real returns. The downside risk of an investment strategy can be measured using lower partial moment (LPM). The LPM for IRR of an investment strategy is calculated as:

$$LPM_{\lambda} = \frac{1}{n}\sum_{j=1}^{n} Max\left[0, IRR_T - IRR_j\right]^{\lambda}$$

where

IRR_T = the target IRR

IRR_j = is the IRR from the *j*th trail of the simulation

n = the number of trails in the simulation (n = 10,000)

λ = 0, 1 or 2

For each investment strategy, three LPMs will be calculated based on λ= 0, 1 and 2. As discussed by Basu and Drew (2010), λ can be interpreted as a risk tolerance measure. λ= 0 implies risk neutral and $\lambda > 0$ implies risk aversion where a higher value reflects a higher degree of risk aversion. When λ= 0, LPM_0 represents the probability that the actual IRR will be less than IRR*T*. When λ = 1, LPM_1 represents the average value of the IRR shortfall. When λ= 2, LPM_2 represents the semi-variance measure. In order to make the scale comparable to IRR, after the semi-variance is calculated, we will take the square-root and use the result as LPM_2.

Risk-adjusted return will be used to measure investment performance. First, the Sharpe's ratio (SHR) is calculated for each strategy as follows.

$$SHR = \frac{E[IRR_p] - IRR_T}{\sigma_p}$$

where
$E[IRR_p]$ = the mean value of IRR from the simulation for strategy p
σ_p = is the standard deviation of IRR from simulation for strategy p

However, Sharpe's ratio uses standard deviation to capture the investment risk. As an alternative measure that focuses on shortfall risk, we will also employ Sortino Ratio (*STR*) as follows:

$$STR = \frac{E[IRR_p] - IRR_T}{[LPM_2]^{1/2}}$$

Both risk-adjusted return measures will be calculated for each investment strategy.

RESULTS

This section of the paper reports the simulation results. First, the distributions of investment outcomes from five competing strategies are analyzed. Second, the downside risk and risk-adjusted performance among the five strategies are analyzed to search for an appropriate default plan. The last part repeats the analysis but this time assumes that there is an equity market crash when the member is 57 years' old.

Distribution of Terminal Wealth (W_T) and IRR over the Holding Period

Table 6 reports the distribution of terminal portfolio value (W_T) that the member will receive at retirement. Based on the average value and standard deviation, more aggressive strategies with higher weights on equities produce higher expected wealth and at the same time incur a higher level of risk. The average W_T from Default is 2.91 million baht, but it is 3.63 million and 4.25 million from Moderate and Aggressive, respectively. Lifecycle produces average W_T of 3.33 million, while Lifecycle-X produces 3.95 million baht. Portfolio risk (standard deviation of W_T) follows the same pattern. However, when holding average portfolio weights over the investment horizon constant, it is found that a fixed portfolio strategy produces a higher expected terminal value and has a higher risk. For example, average W_T is 3.63 million for Moderate and 3.33 million for Lifecycle, and standard deviation (SD) of W_T is 1.30 million for Moderate and 1.07 million for Lifecycle.

To examine which of the five asset allocation strategies are suitable as default plans, we will focus on real returns on portfolios. We measure real return from each investment strategy using IRR over the investment horizon. Table 7 reports the distribution of the real IRRs from the 10,000 trails of simulation. The average value and standard deviation of IRRs follow the same pattern as W_T. Among the fixed allocation, more aggressive strategies produce higher mean returns and at the same time higher risks than less aggressive strategies. The difference in the mean of IRR between Aggressive and Default plans is as high as 1.40% per year, while the difference in standard deviation is only 0.78% per year. This pattern can also be observed when comparing IRR outcomes between Lifecycle and Lifecycle-X.

Table 6: Distribution of Terminal Wealth (W_T, Baht)

	Default	Moderate	Aggressive	Lifecycle	Lifecycle-X
Average	2,914,589	3,628,375	4,245,747	3,327,687	3,953,352
Standard Deviation	670,360	1,299,366	1,957,656	1,069,779	1,661,841
Min	1,337,609	1,157,432	1,007,674	1,215,936	1,173,399
1st Percentile	1,736,934	1,697,249	1,632,358	1,734,780	1,722,509
5th Percentile	2,006,707	2,045,951	2,053,600	2,038,103	2,076,478
Median	2,814,334	3,367,079	3,789,894	3,114,595	3,572,480
95th Percentile	4,168,188	6,117,310	7,984,746	5,350,219	7,141,975
99th Percentile	4,921,417	7,990,994	11,161,576	6,847,835	9,746,690
Max	7,161,494	14,668,869	24,230,291	11,797,219	20,161,526

When comparing between fixed asset allocation and corresponding lifecycle plans, the results show that fixed allocation tends to have a slightly higher expected return (mean IRR) and risk (SD of IRR) than their lifecycle allocation counterparts. In general, balanced strategies that assign higher portfolio weights on equities produce higher expected return and at the same time create wider variability in returns compared to more conservative strategies. In addition, fixed allocations are likely to produce higher expected return and wider variability in returns compared to comparable lifecycle allocations.

Table 7: Distribution of Real IRR

	Default	Moderate	Aggressive	Lifecycle	Lifecycle-X
Average	3.96%	4.84%	5.39%	4.49%	5.15%
Standard Deviation	1.11%	1.57%	1.89%	1.42%	1.73%
Min	-0.40%	-1.44%	-2.54%	-1.08%	-1.34%
1st Percentile	1.30%	1.15%	0.91%	1.29%	1.25%
5th Percentile	2.15%	2.26%	2.28%	2.23%	2.34%
Median	3.95%	4.83%	5.38%	4.45%	5.11%
95th Percentile	5.81%	7.46%	8.52%	6.90%	8.08%
99th Percentile	6.54%	8.53%	9.80%	7.92%	9.29%
Max	8.10%	10.80%	12.55%	10.01%	11.92%
CV	28.07%	32.43%	35.11%	31.72%	33.70%
IQRR	1.47%	2.09%	2.52%	1.93%	2.33%
Prob.(IRR < 0)	0.000	0.001	0.003	0.001	0.002

Since one of the GPF's investment objectives is capital preservation, we turn our attention to the probability that each strategy will generate a negative IRR. It is found that the probability of a negative IRR is almost zero in all strategies. The strategy that creates the highest chance of capital lost is Aggressive, but that probability is merely 0.3%. Therefore, it can be concluded that based on the five allocation strategies investigated in this paper, the chance of capital lost in long-term investment is very low whether the allocation strategy is aggressive or conservative or whether it is fixed or time-varying.

Now we turn to the distribution of IRRs. More aggressive strategies produce lower minimum IRR compared to a less aggressive plan. However, minimum value can be viewed as an extreme case. We will focus on the 5th and 95th percentiles of IRR distributions. Note that the q^{th} percentile from a probability distribution represents Value at Risk at q confidence level or VaR[q]. Therefore, we can interpret the 5th percentile IRR as the downside risk, and the 95th percentile as the upside potential. As can be seen from the table, both the 5th and 95th percentile IRRs from aggressive strategies are higher than those from less aggressive strategies. For example, the 5th percentile IRR is 2.28% from Aggressive and 2.15% from Default[13]. This observation is consistent across fixed allocation strategies and across lifecycle strategies. The finding indicates that, apart from very extreme cases, strategies with more weights on equities have a lower tailed risk, and at the same time, higher upside potential than conservative strategies.

IQRR, which measures the rage of IRR distribution between 75th and 25th percentiles, reflects how disperse the distribution is. From Table 7, it can be seen that IRRs from aggressive strategies are more disperse than their conservative counterparts. This implies that aggressive strategies are riskier in terms of return variability. However, when looking closer, it is found that both IRRs in the 25th and 75th percentiles from aggressive strategies are higher than the corresponding IRRs from conservative strategies. Overall, strategies that are more aggressive toward equities tend to give preferable distribution of IRR relative to conservative strategies. In addition, fixed allocations tend to produce preferable distribution of IRR compared to their lifecycle counterparts, but the difference is small in this case.

The coefficient of variation (CV) reported in Table 7 is calculated as the ratio between standard deviation and the mean of IRR distribution. This measure is used for comparing the degree of variation between various distributions. Consistent with IQRR, strategies with more weights on equity produce more dispersion in the IRR. Fixed allocation strategies also create more dispersion in IRR compared to their lifecycle counterparts. This means that for aggressive strategies, the chance that actual IRR may be different from the mean value is higher than conservative strategies. The same thing can be said between fixed and lifecycle allocations.

Downside Risk and Risk-Adjusted Returns

According to the GPF's statement, "It is our belief that the return should be higher than inflation rate to enhance the quality of life after retirement. Therefore, the ultimate long-term target return is set to be higher than long-term inflation"[14]. In this paper, we take the investment objectives of the GPF as to meet a certain targeted real IRR (IRR_T) in the long-run, while maintaining capital preservation. However, the policy statement does not specify the exact figure for target real return. We will therefore assume various levels of target IRR to analyze downside risk of competing strategies. According to the GPF's annual report 2015[15], the actual real investment return since the GPF was established until the end of 2015 was about 4.0% per year. It is possible

[13] It can be interpreted, as there is 5% chance that IRR from Aggressive and Default strategies will be less than 2.28% and 2.15% per year, respectively.
[14] http://www.gpf.or.th/eng2012/invest_objective.asp
[15] GPF's Annual Report 2015 (www.gpf.or.th/download/annual/Gpf2557.pdf)

that GPF members use this historical performance to form their expectation about the future. We will set possible values of IRR_T surrounding this 4% figure, specifically, 2%, 3%, and 4%.

Table 8 reports the downside risk and risk-adjusted returns from the five competing strategies. First, LPM_0 reflects the probability that the actual IRR will be less than the target level. When the IRR_T is set to be as low as 2% per year, the probabilities of IRR being lower than the target level are similar across all five strategies. Interestingly, however, when IRR_T is raised above 2%, the Default plan produces the highest shortfall probabilities (18.92% and 51.75% for IRR_T = 3% and 4%, respectively). With IRR_T = 3% or above, aggressive plans produce less shortfall probabilities than conservative plans and fixed allocation strategies produce less shortfall probabilities compared to their lifecycle counterparts.

Second, LPM_1 is the average deviation of actual IRR below IRR_T. Again, when IRR_T is set to be 2% per year, the average value of IRR shortfall across five strategies are similar, about 0.02% per year. However, when IRR_T is set to be 3% or above, the Default plan produces the highest average IRR shortfall, ranging from 0.12% and 0.46% when IRR_T are 3% and 4%, respectively. When IRR_T is set at 3%, four strategies, excluding Default, produce similar value of average IRR shortfalls. For IRR_T above 3%, it is shown in the table that aggressive strategies produce lower average IRR shortfalls than conservative strategies. Again, fixed asset allocation strategies produce lower average IRR shortfalls than their lifecycle counterparts.

Third, LPM_2 reflects semi-standard deviation. While LPM_1 weighs each deviation from the target equally, LPM_2 penalizes larger deviation more by taking the average of square deviation below $IRR_{T.}$ Unlike LPM_0 and LPM_1, when IRR_T is set to be 2%, the Default plan produces the lowest LM_2 value, implying that the Default plan has the lowest shortfall risk. Furthermore, conservative strategies have lower LPM_2 compared to aggressive strategies. However, as IRR_T is set to be higher, the relation between investment aggressiveness and downside risk is reversed. In conclusion, when IRR_T is low (between 2-3% pa.), less aggressive strategies possess lower downside risk than more aggressive ones. However, when IRR_T is above 3%, aggressive strategies will create a lower downside risk.

LPMs mainly capture the downside risk. However, to assess the appropriateness of investment plans, LPMs fail to capture another important aspect of investment, the expected return. Table 8 shows the results on two measures of risk-adjusted performance, namely, Sharpe's Ratio (SHR) and Sortino's Ratio (STR). We find that the results from both measures are very similar. At all levels of the target return, aggressive strategies tend to produce higher risk-adjusted returns than less aggressive ones. The only exception is the relative performance between Moderate and Aggressive strategies when IRR_T = 2%. In addition, fixed allocations tend to perform better than lifecycle allocations on a risk-adjusted basis. This is true whether we use SHR or STR.

Table 8: Downside Risk and Performance Measurement

	Default	Moderate	Aggressive	Lifecycle	Lifecycle-X
			IRR_T = 2.0%		
LPM_0	3.79%	3.48%	3.83%	3.47%	3.14%
LPM_1	0.02%	0.02%	0.03%	0.02%	0.02%
LPM_2	0.13%	0.17%	0.21%	0.14%	0.16%
SHR	1.76	1.81	1.79	1.75	1.81
STR	15.54	16.99	15.92	17.30	19.17
			IRR_T = 3.0%		
LPM_0	18.92%	11.49%	9.91%	14.41%	10.05%
LPM_1	0.12%	0.09%	0.10%	0.10%	0.08%
LPM_2	0.36%	0.36%	0.40%	0.35%	0.35%
SHR	2.70	5.09	5.96	4.27	6.20
STR	0.87	1.17	1.26	1.05	1.24
			IRR_T = 4.0%		
LPM_0	51.75%	29.74%	22.69%	37.43%	25.46%
LPM_1	0.46%	0.29%	0.25%	0.35%	0.25%
LPM_2	0.81%	0.69%	0.70%	0.73%	0.66%
SHR	-0.03	0.54	0.74	0.35	0.66
STR	-0.05	1.21	2.00	0.67	1.75

The Case of Equity Market Shocks near Retirement

Table 9 reports simulation results similar to Table 7, but this time we assume that there is a global equity market crash when the member is 57 years old, or 3 years before her retirement. We assume that the crisis lasts for 1 year.

Interestingly, even when equity market crash is assumed to happen 3 years before retirement, the average IRRs from aggressive strategies still outperform conservative strategies, while the standard deviations of IRRs are also higher in aggressive strategies. However, the relative distributions of IRRs between aggressive and conservative strategies have changed. Based on the 5th and 95th percentiles, we now find that less aggressive strategies actually produce lower downside risk, but more aggressive strategies produce higher upside potential for portfolio returns.

When comparing between fixed and time-varying asset allocation, we find that lifecycle plans produce higher mean IRR but lower standard deviation of IRR compared to their fixed allocation counterpart. In addition, both the 5th and 95th percentile IRR from lifecycle plans are higher than their fixed allocation counterparts. This implies that with the equity market crisis, lifecycle plans produce lower downside risk, while at the same time with a higher upside potential. Furthermore, as far as capital losses are concerned, the probability of negative IRR is lower in lifecycle allocations compared to fixed allocation.

Table 9: Distribution of Real IRR with Equity Market Shock

	Default	Moderate	Aggressive	Lifecycle	Lifecycle-X
Average	3.61%	4.09%	4.34%	4.60%	4.89%
Standard Deviation	1.08%	1.57%	1.94%	1.40%	1.74%
Min	-0.84%	-2.83%	-2.91%	-0.40%	-1.61%
1st Percentile	1.06%	0.35%	-0.32%	1.47%	0.86%
5th Percentile	1.83%	1.47%	1.11%	2.35%	2.06%
Median	3.60%	4.08%	4.34%	4.56%	4.85%
95th Percentile	5.38%	6.64%	7.48%	6.95%	7.78%
99th Percentile	6.05%	7.66%	8.67%	7.90%	8.93%
Max	7.94%	10.44%	11.96%	10.41%	11.98%
CV	0.30	0.38	0.45	0.31	0.36
IQRR	1.46%	2.15%	2.64%	1.91%	2.36%
Prob.(IRR < 0)	0.000	0.006	0.014	0.000	0.002

CONCLUSION

Although regulators in many countries do not provide an exact prescription of asset allocation of a mandatory DC plan, they do stress the importance of diversification (Basu and Drew, 2009). To this end, plan providers have some flexibility in the structure of a default plan that they will offer to the plan members. In this study, we investigate the appropriateness of various balanced asset allocation strategies as a default plan. Risk is defined in the context of investment for retirement as the chance that the actual return on investment will fall short of a target return. Our results show that compared to conservative asset allocations, higher allocation to equities is less risky on most occasions. Balanced strategies that tilt toward equities not only reduce the chance of falling short of a target return, but also decrease the magnitude of shortfall in case members fail to achieve such target. At the same time, equities also enhance the upside potential by capturing a high-risk premium from that class of assets.

We show that given the same average asset allocation over a long investment horizon, fixed asset allocations tend to outperform comparable lifecycle strategies. However, it is found that lifecycle strategies prove to be very useful against possible equity market crash, especially, if the crash occurs near retirement. Given that pension members are known to be inertia and have little financial knowledge, keeping high proportion of portfolio on equities, especially near retirement, makes them vulnerable. It is not surprising that lifecycle strategies become one of the most popular strategies adopted as default plans by fund providers.

We also show that the relative downside risks between conservative vs. aggressive and fixed vs. lifecycle allocations depend on the target outcomes. When the target return is set to be low, downside risks are similar across strategies. However, when the target return is set to be high, aggressive strategies and fixed allocation strategies possess lower downside risk relative to their counterparts.

Based on the fact that GPF does not give an exact figure for the target real return and the possibility that plan members may base their expectations on the actual historical real return (which is 4% per year), our findings raise two questions regarding the current default plan offered by the GPF. Firstly, the simulation results estimate that the long-run expected real return is 3.96% per year with standard deviation of 1.11% per year. This is very close to the historical performance by GPF. However, whether GPF will be able to maintain performance in the long-run with the current default plan becomes questionable. Our results indicate that with 4% target return, the chance of shortfall is as high as 51.57%. Second, given that the fund members are inertia, it may be worthwhile to consider lifecycle as a default plan. This is to prevent events similar to 2008 when members of the DC plans who retired in that year had to incur significant investment loss[16]. We find that lifecycle strategy provides a hedge against inertia. By moving from fixed to lifecycle strategies our results show that the member does not have to sacrifice much of the upside gain. Overall, our findings suggest the appropriateness of a lifecycle asset allocation that tilts toward equities as the default plan.

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