Mandatory Provident Fund Schemes Authority

A 15-year Investment Performance Review of the MPF System (1 December 2000 – 30 November 2015)

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EXECUTIVE SUMMARY

1. This report is prepared to review the investment performance of the Mandatory Provident Fund ("MPF") System from the commencement of the MPF System on 1 December 2000 to 30 November 2015 (the "review"). The review aims to provide MPF scheme members ("members") and other stakeholders with a better understanding of the investment performance of the MPF System and different types of MPF funds over a 15-year period. All figures on return or performance in this report are net of (i.e. after deducting) fees and charges.

KEY FINDINGS

Performance of the MPF System as a Whole

2. From 1 December 2000 to 30 November 2015, a total net amount of $475.20 billion was contributed to the MPF System. As of 30 November 2015, those total net contributions had grown to $589.55 billion of accrued benefits. This means that investment returns had added $114.35 billion to the net contributions of members. Over the 15-year period, the MPF System recorded an annualized return of 3.1% after fees and charges.[1]

3. Since MPF assets are invested in financial instruments, the performance of the MPF System hinges on the conditions of underlying investment markets. As driven by corresponding changes in underlying investment markets, the yearly performance of the MPF System fluctuated during the review period, ranging from a negative yearly return of -25.9% to a positive yearly return of 30.1%.

4. The MPF System is characterized by a relatively high exposure to equities (more than 60% of total assets) and Hong Kong equities in particular (almost 40% of total MPF assets), the performance of which has great impact on the overall return of the MPF System. In addition, around 15% of MPF assets were regularly invested in bank deposits or held in cash. The persistently low interest rate environment in recent years has dampened the overall MPF return.

5. It should however be noted that the return figures are system-wide figures. Individual members' MPF accounts will have displayed returns in excess of, or lower than, the MPF System as a whole, depending primarily on their choice of fund and the timing of their contributions.

[1] The return of the MPF System was calculated by way of the internal rate of return ("IRR"), a method commonly known as dollar-weighted return. The IRR method takes into account the amount and timing of contributions made into and benefits withdrawn from the MPF System. For details of the calculation methodology, please refer to Appendix B.

Performance of Different Types of MPF Funds

6. A total of 585 MPF funds, which had operated in the MPF System at any point in time during the 15-year period, were included in the review. Funds have been categorized under one of six types, namely, equity funds, mixed assets funds, bond funds, guaranteed funds, MPF conservative funds and money market funds & others.[2]

7. All six types of funds added value to contributions over the 15-year period, albeit in different degrees. As a group, equity funds, mixed assets funds and bond funds achieved relatively better performance, producing annualized returns of 4.1%, 3.9% and 2.8% respectively for the 15-year period. At the other end of the spectrum were guaranteed funds, MPF conservative funds and money market funds & others which generated annualized returns of 1.3%, 0.8% and 0.6% respectively.[3]

8. For equity funds, the performance varied considerably depending on the geographical allocation of assets. Over the 15-year period, the best performing sub-category was Asia equity funds, followed by Hong Kong equity funds, Global equity funds, North America equity funds and Europe equity funds.

9. Within mixed assets funds, the fund performance varied depending on the composition of equities and bonds in a fund, and the performance of the underlying equity and bond markets. For bond funds, Global bond funds outperformed Hong Kong bond funds.

10. MPF conservative funds and money market funds & others achieved returns lower than other fund types as would be expected given the types of underlying assets. The investment performance of these two fund types has been particularly affected by the persistently low interest rates of major currencies.

Relationship between Risk and Return

11. The risk level of MPF funds was examined by measuring the standard deviation of monthly returns. Based on the value of the standard deviation of the six types of MPF funds, equity funds had the highest level of risk, followed by mixed assets funds, bond funds, guaranteed funds, money market funds & others and MPF conservative funds.

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[2] Money market funds & others cover money market funds that are not MPF conservative funds and uncategorized funds as per the Performance Presentation Standards for MPF Investment Funds.

[3] In view of the absence of available data on contributions made into and benefit withdrawn from MPF funds, the returns of different types of MPF funds were calculated by way of the time-weighted method instead of the dollar-weighted method. The time-weighted method takes into account the unit price and asset size of each constituent fund at different points in time. For details of the calculation methodology, please refer to Appendix B.

12. The review also examined the risk level by measuring the range of monthly returns ("range") generated over a period of time. On this basis, equity funds again had the highest level of risk, while MPF conservative funds had the lowest. The overall results were similar to those based on the analysis of the standard deviation.

IMPLICATIONS AND CONCLUDING REMARKS

Saving Outcome of Individuals Hinges on Members' Investment Decisions

13. Under the MPF System, all members can choose between MPF funds in the scheme in which they are enrolled. The review indicates that fund choices made by members will have an important impact on their saving outcomes. For instance, over the 15-year period, the cumulative return of equity funds amounted to 83.0%, while that of the group categorized as "money market funds & others" was 8.8% only. Expressed in another way, equity funds returned, on average, more than nine times as much as money market funds & others over the review period. These return figures however have to be understood in the context of associated risk levels. Equity funds had the highest level of risk with the range of monthly returns as wide as 36.02 percentage points in the 15-year period, while money market funds & others had a range as narrow as 1.89 percentage points.

The Overall System Return Relating Closely with Members' Collective Choices

14. The investment performance of the MPF System as a whole relates closely with members' collective choices. Members' fund choices, put together, have a substantial impact on the overall asset allocation of the MPF System. A salient characteristic of members' collective choices is the dominance of Hong Kong and other Asian markets in the overall allocation of MPF assets. As a result of members' preferences, the outcomes in the financial markets in Hong Kong and other Asian markets weighed heavily on the investment performance of the MPF System during the review period.

15. The return of the MPF System is often compared with some common benchmarks such as the Tracker Fund of Hong Kong ("TraHK"). However, the MPF System comprises not a single fund but a range of funds with different investment objectives. The asset allocation of the MPF System is, therefore, mixed and varied, unlike the TraHK, which puts the focus on Hong Kong equities only. Given each asset class has its unique risk and expected return characteristics, comparing the performances of two portfolios with different asset allocations and investment objectives will not be meaningful.

MPF Returns Should be Considered over the Long-Term

16. The results of the review show that the investment performance of MPF funds, particularly that of growth funds like equity funds and mixed assets funds, recorded substantial fluctuations during the review period. MPF is a long-term investment, spanning across a period of more than 40 years. The investment returns of MPF funds during this period will be inevitably affected by the cycle of financial markets which can in some cases be quite extreme. Depending on the timing of their need to access accrued benefits, members should not be overly concerned with short-term return fluctuations. Members should however consider the impact that substantial fluctuation might have on their accrued benefits as they approach the age when they can access benefits, which is 65 for most people. There would be limited opportunity to recoup large losses incurred immediately before retirement. In this respect the MPFA has proposed a new, standardized, default investment strategy that, amongst other attributes, will automatically reduce risk as the member approaches age 65. It is expected that the default investment strategy will be implemented by the end of 2016.

Strong Relationship between Risk and Return

17. The review suggests that MPF funds had generally exhibited the expected relationship between risk and return, that is, the higher the potential return in the long run, the higher the risk.

18. The review findings also suggest that diversification across regions or asset classes tends to lower the overall investment risk.

Looking at Past Performance with Care

19. Readers are reminded that the return figures set out in this report are only intended to give a generalized indication of the progress of the MPF System and the relationship between risk and return. The fund-type figures set out in the report should not be seen as providing any firm indicator for predicting future absolute performance of MPF funds. As reflected in the report, they may however be somewhat indicative of reasonable expectations about the relative risk and return attributes of different fund types.

20. Members should not make fund choice decisions solely based on short- or even medium-term historical performance. Other relevant factors such as the suitability of individual MPF funds for their own circumstances, fees and charges, and quality of services need to be considered. Members should also note that past performance is not indicative of future performance.

CHAPTER 1 INTRODUCTION

Objectives

1. The Mandatory Provident Fund ("MPF") System has been in operation for 15 years. This report is prepared to review the investment performance of the MPF System for the period from the commencement of the MPF System on 1 December 2000 to 30 November 2015 (the "review"). The objectives of the review are to:

   (a) provide MPF scheme members ("members") and other stakeholders with a better and objective understanding of the investment performance of the MPF System as a whole and of the different types of MPF constituent funds ("MPF funds") for the period from 1 December 2000 to 30 November 2015; and

   (b) help members understand the implications of the investment performance review and how that might assist them in managing their MPF investments.

Scope

2. The review examines the investment returns ("returns" or "performance") of the MPF System and of the different types of MPF funds over a 15-year period, from 1 December 2000 to 30 November 2015 ("15-year period" or "review period"). All figures on return or performance in this report are net of (i.e. after deducting) fees and charges.

3. Every MPF fund that had operated in the MPF System at any point in time during the 15-year period was included in the analysis. A total of 585 MPF funds were included in the review, of which 459 were existing funds as of 30 November 2015 ("existing MPF funds") and 126 were terminated before 30 November 2015 (Table 1).

Table 1 **Number of MPF Funds Covered in the Review by Fund Type**

Fund Type	Number of MPF Funds Covered in the Review			% of Total Number of MPF Funds
	Number of Existing MPF Funds as of 30 Nov 2015	Number of MPF Funds Terminated before 30 Nov 2015[i]		
Mixed Assets Fund	*168*	*59*	**227**	**38.8%**
Equity Fund	*171*	*19*	**190**	**32.5%**
MPF Conservative Fund	*38*	*21*	**59**	**10.1%**
Bond Fund	*48*	*4*	**52**	**8.9%**
Guaranteed Fund	*25*	*16*	**41**	**7.0%**
Money Market Fund & Others[ii]	*9*	*7*	**16**	**2.7%**
Total	*459*	*126*	**585**	**100%**

i Returns of the terminated funds were calculated up to the last month with fund price.

ii Covers money market funds that are not MPF conservative funds and uncategorized funds as per the Performance Presentation Standards for MPF Investment Funds.

Source: MPFA

4. Table 2 shows the net asset values of MPF funds by fund type as at 30 November 2015.

Table 2 **Net Asset Values of MPF Funds by Fund Type as of 30 November 2015**

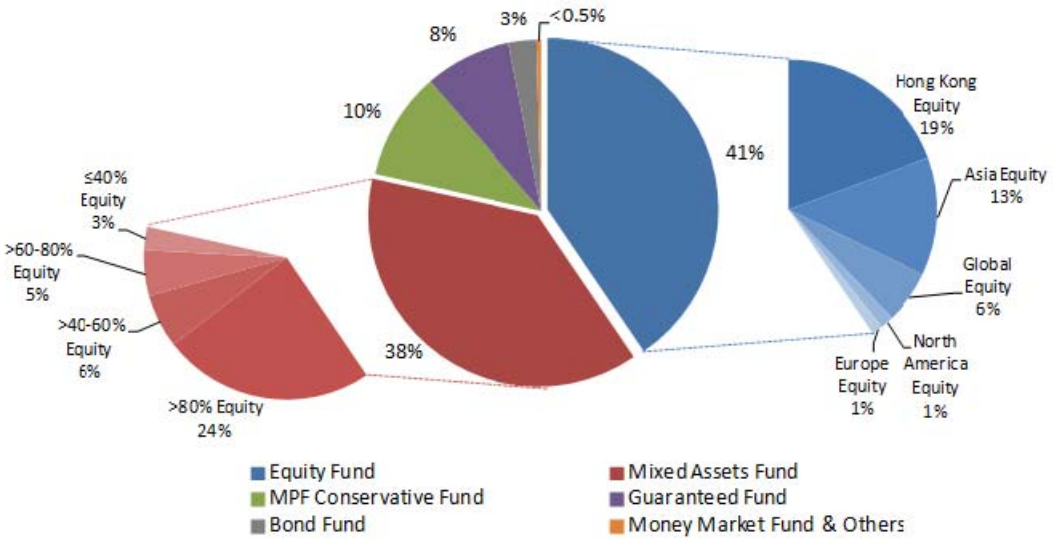
Fund Type	$ million	% of Total
Equity Fund	238,798	41%
Mixed Assets Fund	223,721	38%
MPF Conservative Fund	60,013	10%
Guaranteed Fund	48,882	8%
Bond Fund	15,575	3%
Money Market Fund & Others	2,556	< 0.5%
Total*	**589,546**	**100%**

* Figures may not sum up to the total or 100% due to rounding.

Source: MPFA

5. Chart 1 sets out the percentage share of net asset values of MPF funds by fund type as of 30 November 2015.

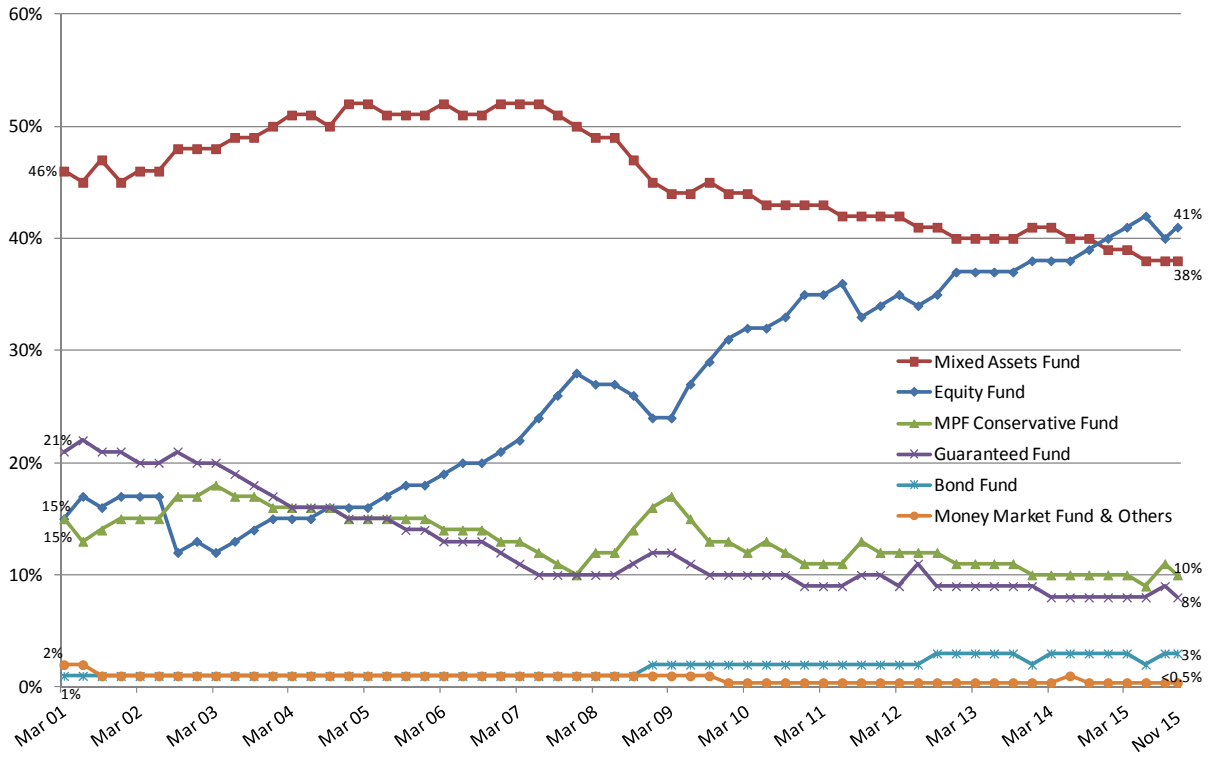
Chart 1 **Percentage Share of Net Asset Values of MPF Funds by Fund Type as of 30 November 2015**



Note: Percentages may not sum up to the overall percentage or 100% due to rounding.

Source: MPFA

Chart 2 **Changes in Percentage Share of Net Asset Values of MPF Funds by Fund Type**



Source: MPFA

6. It is a marked development that the share of equity funds in the overall net asset values of MPF funds increased substantially over the past 15 years, from 15% as at March 2001 to 41% as at November 2015. By contrast, the share of guaranteed funds dropped from 21% to 8% during this period (Chart 2).

Methodology

7. Broadly speaking, the following methodology was employed in conducting the review:

(a) Categorization of MPF Funds

(i) For those parts of the review that consider performance by fund type, MPF funds were classified into six types, namely, equity funds, mixed assets funds, bond funds, guaranteed funds, MPF conservative funds and money market funds & others.

(ii) The categorization was mainly based on the fund type as specified in the Fund Descriptor of the latest Fund Fact Sheet of the relevant scheme.

(iii) For further analysis, equity funds, mixed assets funds and bond funds are classified into sub-types.

(iv) Appendix A sets out the general features of the six types of MPF funds and the detailed methodology for categorization.

(b) Calculation of Returns

Based on the availability of data, different methods were used for calculating the returns of the MPF System and of different types of MPF funds. The results generated by these different methods might differ to some extent.

(i) Return of the MPF System

The return of the MPF System was calculated by way of the internal rate of return ("IRR"), a method commonly known as "dollar-weighted return". The IRR method, which takes into account the amount and timing of contributions made into and benefits withdrawn from the MPF System, was used as it better reflects cash inflow and outflow of the MPF System. The annualized IRR was calculated by raising the monthly IRR to the power of 12.

(ii) Return of Different Types of MPF Funds

- Owing to the absence of available data on contributions made into and benefits withdrawn from MPF funds by type, returns of different types of MPF funds cannot be calculated by the IRR method. Instead, they were calculated by way of the time-weighted method, which takes into account the unit price and asset size of each MPF fund at different points in time. Unlike the IRR method, it does not capture the impact of the contributions made into and benefits withdrawn from MPF funds.

- In the review, cumulative return refers to the total return of a specific fund type for the entire 15-year period, and annualized return represents the average return of a specific fund type generated each year over the 15-year period.

(iii) It should be noted that all return figures are net figures, i.e. after fees and charges of operating the MPF schemes. Also, the return figure of a specific type of MPF funds represents the weighted-average return of all MPF funds within that specific type and not the performance of any individual MPF fund.

(iv) Appendix B sets out the detailed methodology and adjustments made in calculating the returns of the MPF System and of different types of MPF funds.

(c) Risk Measurements

(i) Two different measures of risk have been adopted in this review. The standard deviation of monthly returns ("standard deviation") (i.e. a measure of fluctuation of monthly returns over time) and range of monthly returns ("range") (i.e. the difference between the highest and lowest monthly return figures) are used as the measurements of risk of different types of MPF funds.

(ii) Appendix C sets out the detailed methodology used in calculating the standard deviation and range.

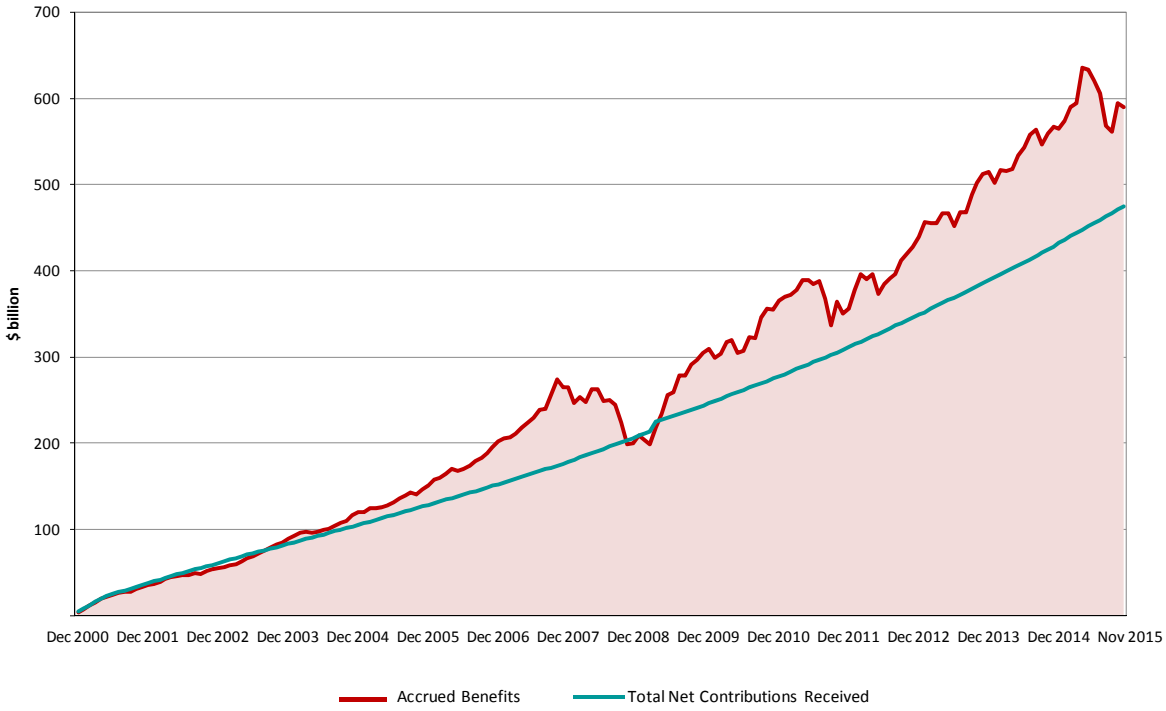
Data Sources

8. All MPF data used in the report was obtained from MPF approved trustees.

CHAPTER 2 PERFORMANCE OF THE MPF SYSTEM AS A WHOLE

9. From the inception of the MPF System to 30 November 2015, a total net amount of $475.20 billion was contributed to the MPF System.[1] As of 30 November 2015, the total net contributions grew to $589.55 billion of accrued benefits.[2] This means that investment returns had added $114.35 billion to the net contributions of members. Chart 3 shows the trend of accrued benefits over the 15-year period. Apart from the early years of implementation, the only period when accrued benefits fell below net contributions was for a relatively short period during the depths of the global financial crisis in 2008.

Chart 3 **Accrued Benefits and Total Net Contributions Received Since the Inception of the MPF System (1 December 2000 – 30 November 2015)**



Source: MPFA

10. As a whole, the MPF System recorded an annualized return of 3.1% over the review period after fees and charges.[3] The yearly performance of relevant markets fluctuated considerably during the review period, resulting in MPF System returns that varied ranging

[1] The amount included mandatory and voluntary contributions of employers, self-employed persons and employees, money transferred from occupational retirement schemes, and special contributions paid by the Government in the period of March 2009 – December 2010, net of withdrawals from the MPF System during the 15-year period.

[2] "Accrued benefits" means the amount of scheme members' beneficial interests in the registered schemes, including contributions together with the income or profits arising from any investments thereof but taking into account any losses in respect thereof.

[3] All system-wide returns presented in this report are annualized dollar-weighted returns.

from a negative annualized return of -25.9% to a positive annualized return of 30.1% (Table 3).

Table 3 **Annualized Internal Rate of Return[i] ("IRR") of the MPF System since Inception**

Period	*($ million)*				Annualized IRR[iii]
	Net Asset Values		Total Net Contributions during the Period[ii]	Net Investment Return[iii] during the Period	
	Period-Beginning (a)	Period-End (b)	(c)	(b)−(a)−(c)	
1.12.2000 – 31.3.2002	-	42,125	43,878	- 1,753	-4.9%
1.4.2002 – 31.3.2003	42,125	59,305	23,016	- 5,837	-10.7%
1.4.2003 – 31.3.2004	59,305	97,041	22,133	15,604	22.0%
1.4.2004 – 31.3.2005	97,041	124,316	22,205	5,070	4.7%
1.4.2005 – 31.3.2006	124,316	164,613	23,435	16,862	12.3%
1.4.2006 – 31.3.2007	164,613	211,199	24,684	21,901	12.4%
1.4.2007 – 31.3.2008	211,199	248,247	26,844	10,205	4.5%
1.4.2008 – 31.3.2009	248,247	217,741	38,503[iv]	- 69,010	-25.9%
1.4.2009 – 31.3.2010	217,741	317,310	29,484 [iv]	70,086	30.1%
1.4.2010 – 31.3.2011	317,310	378,280	31,864 [iv]	29,106	8.7%
1.4.2011 – 31.3.2012	378,280	390,744	34,687	-22,224	-5.6%
1.4.2012 – 31.3.2013	390,744	455,331	38,321	26,267	6.4%
1.4.2013 – 31.3.2014	455,331	516,192	40,898	19,963	4.2%
1.4.2014 – 31.3.2015	516,192	594,847	44,126	34,529	6.4%
1.4.2015 – 30.11.2015	594,847	589,546	31,118	-36,420	-5.9%[v]
Since Inception of the MPF System					
1.12.2000 – 30.11.2015	**-**	**589,546**	**475,196 [iv]**	**114,350**	**3.1%**

i The return of the MPF System was calculated by way of the IRR, a method commonly known as dollar-weighted return. The IRR method, which takes into account the amount and timing of contributions made into and benefits withdrawn from the MPF System, was used as it better reflects the features of cash inflow and outflow of the MPF System. The annualized IRR was calculated by raising the monthly IRR to the power of 12. For details on the calculation method of the annualized IRR, please refer to Appendix B.

ii The amount included mandatory and voluntary contributions of employers, self-employed persons and employees, money transferred from occupational retirement schemes, and special contributions paid by the Government in the period of March 2009 – December 2010, net of withdrawals from the MPF System during the period of December 2000 – November 2015.

iii Return figures are net of fees and charges.

iv Includes $8.41 billion of net special contributions paid by the Government to the eligible MPF/ORSO scheme members in the period of March 2009 – December 2010.

v As the period covered is less than one year, the figure reflects the IRR for the relevant period.

Source: MPFA

11. Since assets of MPF funds are invested in financial instruments, the performance of the MPF System hinges on the conditions of the underlying investment markets. It should be noted that the choice of funds by members directly impacts on System return. The MPF System has significant exposure to equities, mainly through members' investments in equity funds, mixed assets funds, and guaranteed funds. In terms of asset allocation, equities have accounted for more than 60% of the aggregate net asset values of MPF funds in recent years. A significant share of MPF assets is invested in Hong Kong equities. As of 30 September 2015, Hong Kong equities, accounted for 38% of the aggregate net asset values of the MPF System. The fluctuation of investment return of the MPF System during the review period was largely attributed to these features of MPF investment.

12. During the first few years of the inception of the MPF System, the global economy remained sluggish. The performance of the Hong Kong equity market was hurt by the outbreak of the severe acute respiratory syndrome ("SARS") in late 2002. The MPF System recorded annualized returns of -4.9% from December 2000 to March 2002 and -10.7% from April 2002 to March 2003.

13. With a subsequent economic recovery and a significant upsurge in equity markets, the MPF System staged a strong rebound in 2003-04, registering an annualized return of 22.0% for the year. The return of the MPF System moderated to 4.7% in 2004-05, but rebounded again to 12.3% in 2005-06.

14. With the outbreak of the global financial crisis in 2007 and 2008, the global financial markets tumbled, resulting in a plunge of the return of the MPF System by -25.9% in 2008-09. After an extraordinary recovery in the subsequent year (30.1% in 2009-10), the return of the MPF System recorded an annualized rate of -5.6%, partly attributed to the repercussions of the European sovereign debt crisis, in 2011-12.

15. The MPF System experienced another wave of volatility in the second and third quarters of 2015. On the strength of the bullish equity markets, the Hong Kong equity market recorded an upsurge in April 2015. Hong Kong equity funds as a group registered a monthly return of 13.3% in that month. However, a market downturn took place from June 2015 to August 2015. During this period, Hong Kong equity funds as a group posted a negative return of -20.8%, dragging down significantly the overall return of the MPF System.

16. MPF investments have also been facing another challenge. Apart from investing in equities, more than 30% of MPF assets are regularly invested in debt securities and bank deposits/cash. Since the launch of quantitative easing in the United States in 2008, an

increase in money supply has significantly depressed interest rates. The generally low interest rate environment has reduced the returns generated by bonds and bank deposits. As a result, MPF bond funds, MPF conservative funds and money market funds & others reported very moderate performances over the past few years, undermining the overall performance of the MPF System. The performance of different types of MPF funds is discussed in detail in Chapter 3.

17. It should be noted that the MPF System comprises not a single fund but a range of funds with different investment objectives. Therefore, the investment return of the MPF System cannot be compared with some common benchmarks such as the TraHK or the Exchange Fund. Box 1 below provides further discussions about such comparisons.

Box 1: The MPF System vs. The Tracker Fund of Hong Kong

There are often comments by the media and commentators about the performance of the MPF System against a number of simple benchmarks such as retail funds, the TraHK or the Exchange Fund. Whilst it is naturally tempting to look for simple comparison, comparing the return of the MPF system to simple benchmarks such as these is not a valid basis on which any conclusions should be drawn.

Index tracking funds, like the TraHK, are investment funds that replicate the performance of a market index (e.g. Hang Seng Index). The Exchange Fund's primary objective, as laid down in the Exchange Fund Ordinance, is to affect, either directly or indirectly, the exchange value of the currency of Hong Kong. The Exchange Fund may also be used to maintain the stability and integrity of Hong Kong's monetary and financial systems to help maintain Hong Kong as an international financial centre.

The MPF System comprises not a single fund but a range of funds with different investment objectives. The system-wide return is driven by members' collective choices, and the resulting investment returns across many different asset classes and countries. The asset allocation of the MPF System is, therefore, mixed and varied, unlike that of the TraHK which puts the focus on Hong Kong equities only. Given each asset class has its unique risk and expected return characteristics, comparing the performances of two portfolios with different asset allocations and investment objectives will not be meaningful. It should also be recognized that there are costs inevitably associated with administering an individual account retirement savings system like MPF that are not relevant to retail funds, the TraHK or the Exchange Fund.

The table below provides, for illustration, a comparison of the asset allocation between the MPF System and the TraHK. As it shows, there are marked differences between the MPF System and the TraHK in the asset classes and geographical regions that they invest.

Table 4 A Comparison of the MPF System and The Tracker Fund of Hong Kong

	The Tracker Fund of Hong Kong	The MPF System[1]
Asset Class	Equities – 100%	Equities – 65% Debt Securities – 19% Deposits & Cash – 16%
Geographical Region	Hong Kong – 100%	Hong Kong – 62% North America – 14% Europe – 11% Asia – 8% Japan – 5%

[1] Referring to the asset allocation of the MPF System as at 30 Sep 2015.

Source: TraHK and MPFA

18. Readers are reminded that the return figures discussed in this chapter are system-wide figures. Individual members' MPF accounts will have displayed returns in excess of or lower than the MPF System as a whole, depending primarily on their choice of fund and the timing of their contributions.

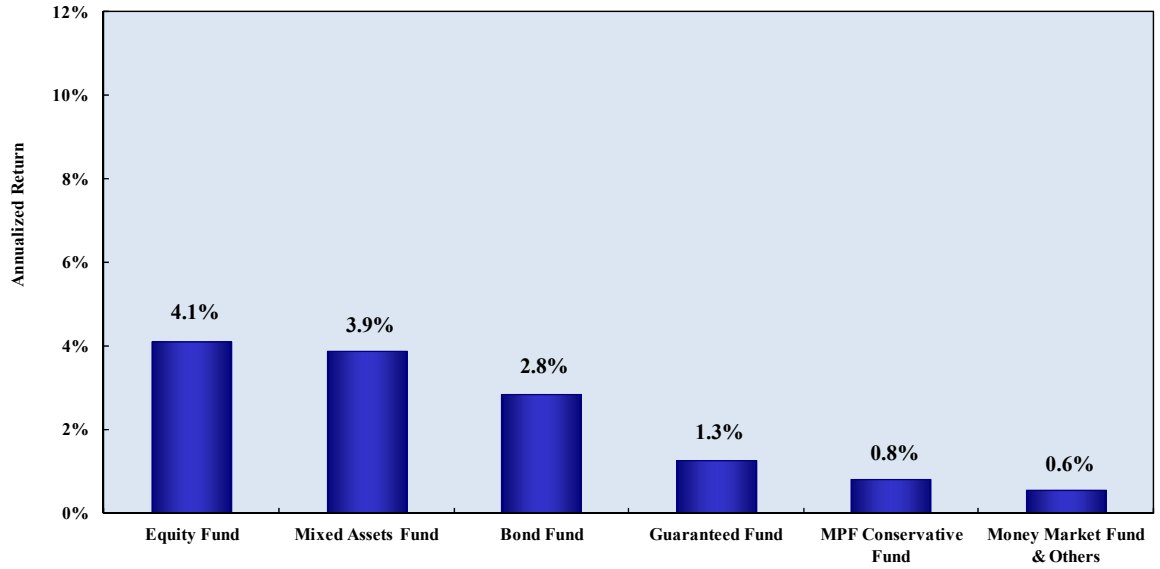
CHAPTER 3 PERFORMANCE OF DIFFERENT TYPES OF MPF FUNDS

Overview

19. MPF funds are categorized under one of six types, namely, equity funds, mixed assets funds, bond funds, guaranteed funds, MPF conservative funds and money market funds & others. Over the 15-year period, all of these six fund types added value to MPF contributions, ranging from 4.1% annualized return for equity funds to 0.6% annualized return for money market funds & others [4] (Chart 4). All return figures are net of fees and charges.

20. As a group, equity funds, mixed assets funds and bond funds produced substantially higher returns than guaranteed funds, MPF conservative funds and money market funds & others over the 15-year period. Equity funds, mixed assets funds and bond funds recorded annualized returns of 4.1%, 3.9% and 2.8% respectively during the period, while guaranteed funds, MPF conservative funds and money market funds & others registered annualized returns of 1.3%, 0.8% and 0.6% respectively (Chart 4).

Chart 4 Annualized Return of MPF Funds by Fund Type (1 December 2000 – 30 November 2015)

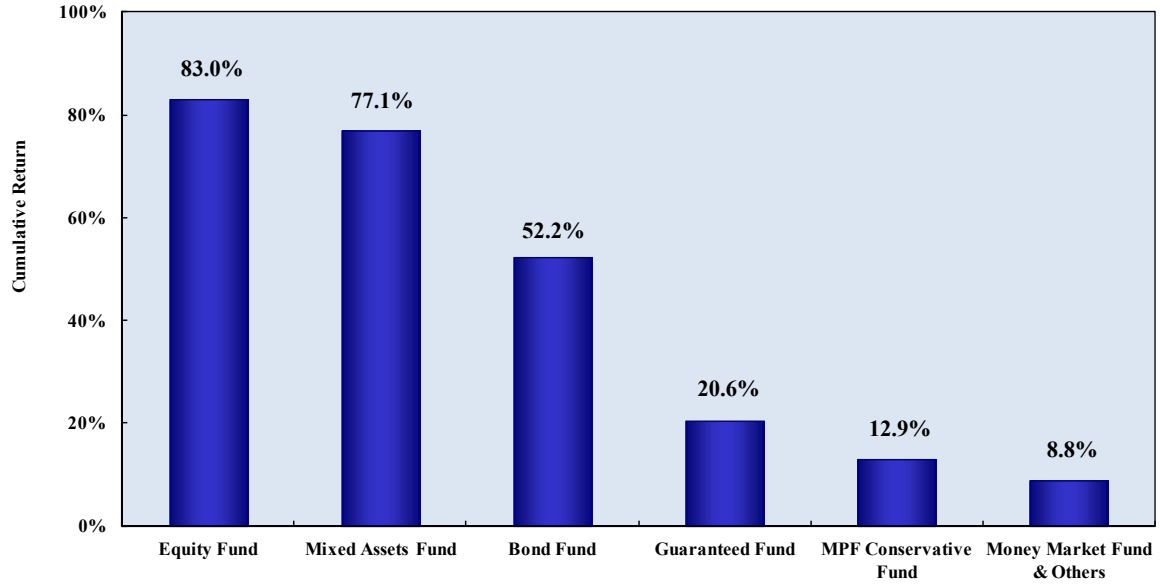


Source: MPFA

[4] In view of the absence of available data on contributions made into and benefits withdrawn from MPF funds, the returns of different types of MPF funds were calculated by way of the time-weighted method instead of the dollar-weighted method. The time-weighted method takes into account the unit price and asset size of each constituent fund at different points in time. For details of the calculation methodology, please refer to Appendix B.

21. Chart 5 shows the cumulative return for all types of MPF funds over the 15-year period.

Chart 5 Cumulative Return of MPF Funds by Fund Type (1 December 2000 – 30 November 2015)



Source: MPFA

Further Analysis of the Performance of Different Types of MPF Funds

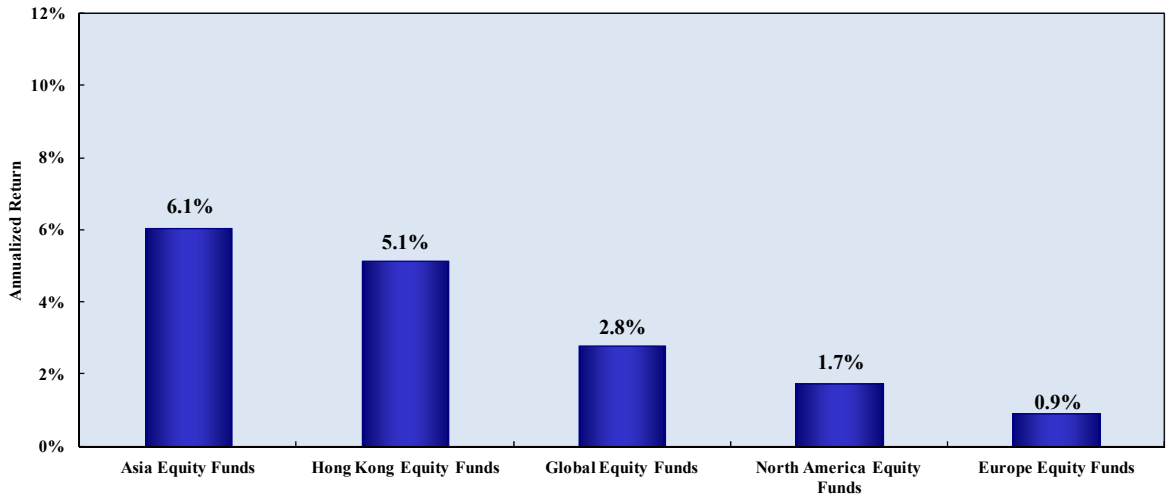
22. Further analysis was conducted in respect of equity funds, mixed assets funds, bond funds and MPF conservative funds to determine, among others, if performances varied with geographical allocation of assets in the case of equity funds and bond funds and with the percentage of equity content in the case of mixed assets funds.

Equity Funds

23. Relatively speaking, equity funds were the best point-to-point performer among all fund types. Over the 15-year period, equity funds reported an annualized return of 4.1%. In cumulative term, a return of 83.0% was generated.

24. Among equity funds, the performance varied considerably depending on the geographical allocation of assets. Of all equity funds, the best performing sub-category was Asia equity funds, producing 6.1% annualized return which were followed by Hong Kong equity funds (5.1%). Global equity funds, North America equity funds and Europe equity funds trailed behind Asia equity funds by some margins, with annualized returns of 2.8%, 1.7% and 0.9% respectively over the 15-year period (Chart 6).

Chart 6 Annualized Return of Equity Funds by Region (1 December 2000 – 30 November 2015)



Note: Asia equity funds included funds investing in Asia (also including Australia and New Zealand) except those investing solely in Hong Kong equities.

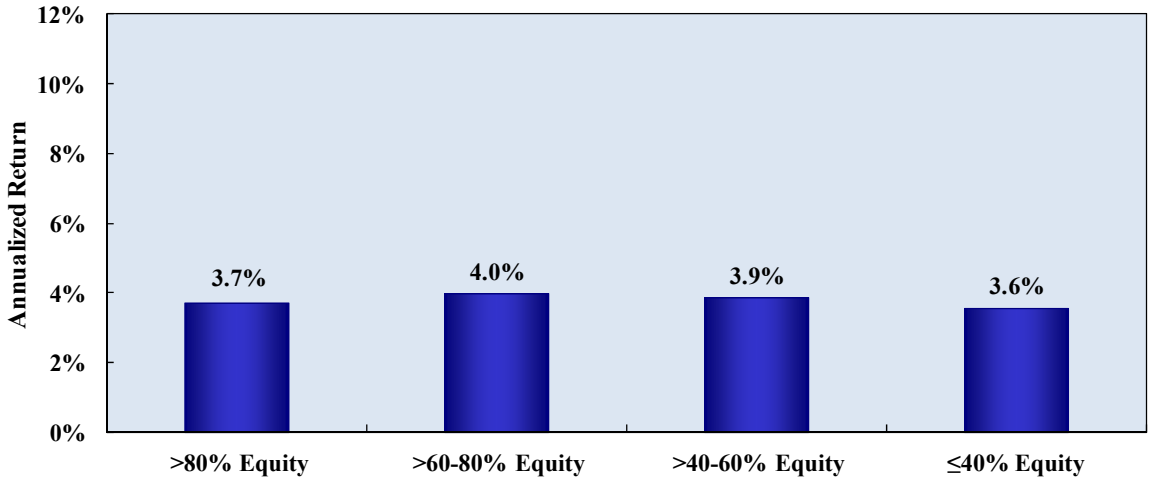
Source: MPFA

Mixed Assets Funds

25. With an annualized return of 3.9%, mixed assets funds took the second place in terms of performance among the six types of MPF funds and were only slightly behind equity funds over the 15-year period.

26. Mixed assets funds could be further categorized into the following four sub-fund types according to the percentage of equity contents: mixed assets funds (≤40% equity), mixed assets funds (>40%-60% equity), mixed assets funds (>60%-80% equity) and mixed assets funds (>80% equity). With an annualized return of 4.0%, mixed assets funds (>60%-80% equity) were the best performer among the four sub-fund types. Mixed assets funds (>40%-60% equity) and mixed assets funds (>80% equity) were the next two in line, registering annualized returns of 3.9% and 3.7% respectively. With an annualized return of 3.6%, mixed assets funds (≤40% equity) recorded the lowest return among the four sub-fund types (Chart 7).

Chart 7 **Annualized Return of Mixed Assets Funds by Percentage of Equity Content (1 December 2000 – 30 November 2015)**



Source: MPFA

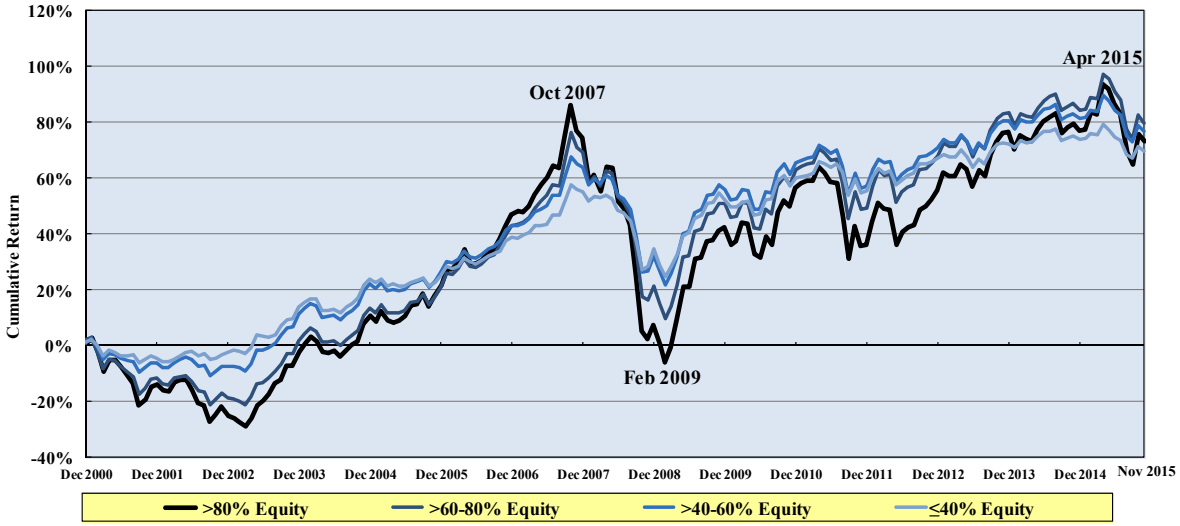
27. Since mixed assets funds generally invest in equity and bond markets, the return of mixed assets funds hinges on the performance of these two markets. The unique characteristic of mixed assets funds could be found in Chart 8. When equity markets were bullish (e.g. around October 2007), the mixed assets funds with higher equity content outperformed those with less equity content. At that time, the higher the equity content of the mixed assets funds, the higher the return. When the conditions of equity markets deteriorated (e.g. late 2008 and early 2009), the performances of these four sub-types of mixed assets funds were reversed. At that time, the higher the equity content of the mixed assets funds, the lower the return. Therefore, the value of diversification is more apparent under volatile market conditions. For mixed assets funds, a more diversified or balanced portfolio tends to produce less volatile returns, and in some cases a higher return, than one with high equity content.

28. A similar pattern could be observed during the period from November 2011 to April 2015. In this period, mixed assets funds (>80% equity) recorded the highest growth in cumulative return (an increase of 57.6 percentage points) followed by mixed assets funds (>60-80% equity) (an increase of 48.5 percentage points), mixed assets funds (>40-60% equity) (an increase of 33.2 percentage points), and mixed assets funds (≤40% equity) (an increase of 24.7 percentage points). Mainly due to the downturn of equity markets since June/July 2015, the relative performances of these four sub-types of mixed assets funds have been reversed again.

29. As such, when choosing mixed assets funds, attention has to be paid to the equity content of the fund which will have a predominant impact on risks and returns compared to other

mixed asset funds. The relationships between risk and return will be discussed in greater details in Chapter 4.

Chart 8 Cumulative Return of Mixed Assets Funds by Percentage of Equity Content (1 December 2000 – 30 November 2015)

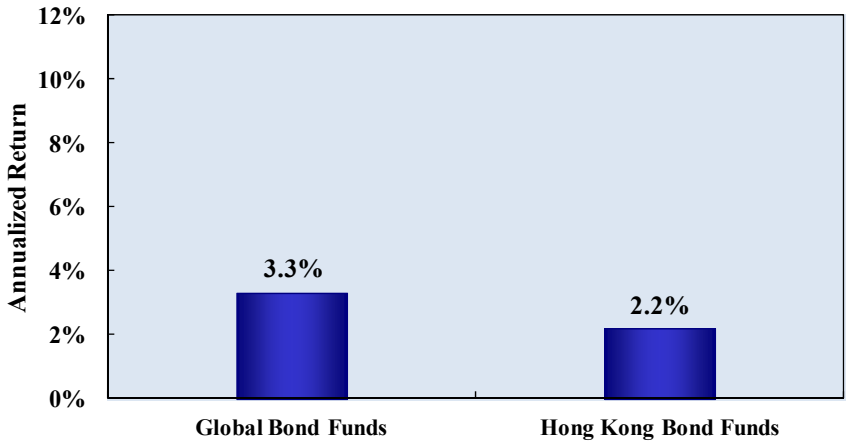


Source: MPFA

Bond Funds

30. With an annualized return of 2.8%, bond funds were the third performer of all fund types over the review period. With a return of 3.3%, Global bond funds outperformed Hong Kong bond funds (2.2%) by a margin of 1.1 percentage point (Chart 9). The relative performance of bond funds may be, in part, related to the economic conditions and interest rate environment of the underlying markets.

Chart 9 Annualized Return of Bond Funds by Region (1 December 2000 – 30 November 2015)



Source: MPFA

MPF Conservative Funds

31. MPF conservative funds were designed as a conservative investment that would broadly earn a rate of return similar to Hong Kong dollar savings deposits with a note-issuing bank in Hong Kong. As such, assets of MPF conservative funds are generally invested in short-term bank deposits with some exposure to bonds. Over the 15-year period, MPF conservative funds recorded an annualized return of 0.8%. As a reference, the annualized return of MPF conservative funds was lower than the growth rate of the Composite Consumer Price Index (1.8% per year), but higher than the annualized Hong Kong dollar savings rate as represented by the Prescribed Savings Rate for MPF conservative fund[5] (0.6% per year) (Table 5). The moderate performance of MPF conservative funds during the review period was largely attributed to the persistently low interest rate environment although it should be noted that these funds did achieve their policy objective of replicating the performance of bank deposits. In fact, as a group MPF conservative funds did better than bank deposits as measured by the Prescribed Savings Rate for MPF conservative fund.

Table 5 **Annualized Return/Change of Indicators (1 December 2000 – 30 November 2015)**

Indicators	Annualized Return / Change
Composite Consumer Price Index % Change	1.8%
Prescribed Savings Rate for MPF Conservative Fund	0.6%

Source: Census and Statistics Department and MPFA

Box 2: The Impact of Compounding on Retirement Savings

The purpose of MPF investment is to save for retirement. It is a long-term investment. How long one makes contributions to the MPF System has a great bearing on the ultimate amount of accrued benefits accumulated upon retirement. The example below aims to show how the effect of compounding over a longer investment horizon could transform a monthly contribution of $1,500 into a better source of income for meeting retirement needs.

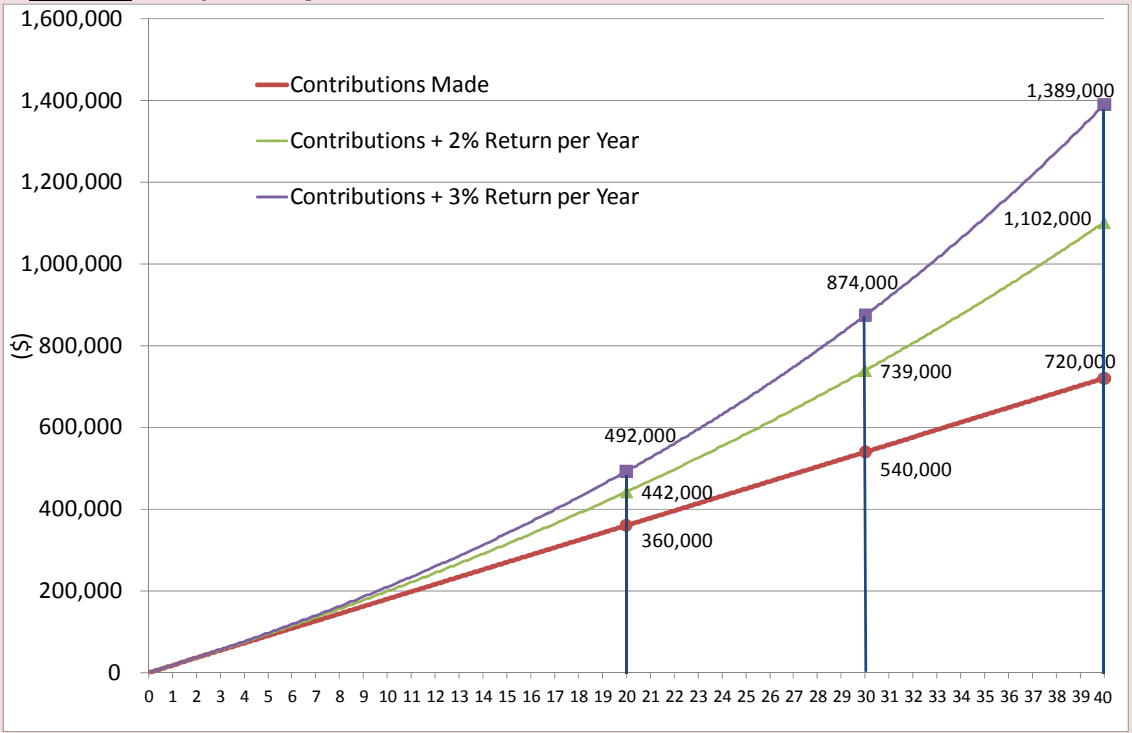
Without the benefit of any investment return, the total amount accumulated would be $360,000 in 20 years and $720,000 in 40 years. With a 2% rate of return per year, the monthly contribution of $1,500 would grow to $442,000 after 20 years and $1,102,000

[5] The Prescribed Savings Rate for MPF conservative fund is the rate at which interest is payable by the three note-issuing banks in Hong Kong in respect of a Hong Kong dollar savings account with deposit amount of $120,000. Where different banks may pay interest on Hong Kong dollar savings accounts at different rates, the Prescribed Savings Rate for MPF conservative fund is the simple average of the interest rates offered for deposit amount of $120,000 by these banks.

after 40 years. For a 3% rate of return per year, the amount of savings will become $492,000 after 20 years and $1,389,000 after 40 years (Chart 10).

Due to the compounding effect, by doubling the investment horizon from 20 years to 40 years, the ultimate accrued benefits would be more than doubled. The compounding effect will become more pronounced for a longer investment horizon and a higher investment return.

Chart 10 Compounding Effects on MPF Contributions



Assumptions:

(i) A month contribution of $1,500 (i.e. 10% of the median income of $15,000) is made.

(ii) The rate of return is net of fees and charges.

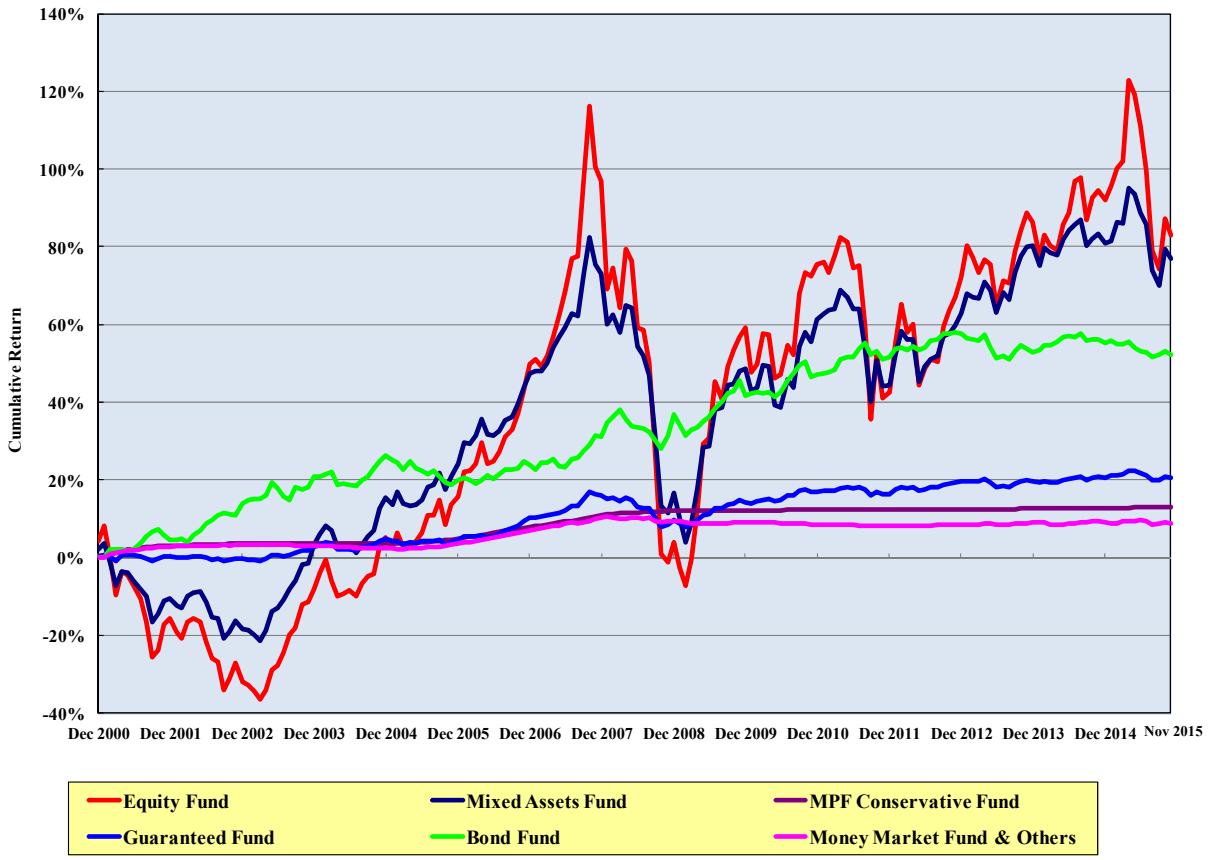
(iii) The inflation rate during the period is assumed as zero.

CHAPTER 4 RELATIONSHIP BETWEEN RISK AND RETURN

Risk Measurements

32. Chart 11 shows the cumulative return of different fund types over the review period. The chart demonstrates that growth funds (e.g. equity funds and mixed assets funds) experienced much more dramatic fluctuation in returns than conservative funds (e.g. MPF conservative funds). Therefore, return figures need to be considered in conjunction with the level of risk taken in achieving those returns.

Chart 11 Cumulative Return of MPF Funds by Fund Type (1 December 2000 – 30 November 2015)



Source: MPFA

33. Risk can be understood and expressed in different ways. One way of expressing risk that has been adopted in the review is in terms of volatility, as measured by the standard deviation of monthly returns. Generally speaking, the higher the standard deviation, the higher the volatility, which can be considered as a higher level of risk.

34. Applied in the current context, the standard deviation measures the variation of monthly weighted returns of a specific type of MPF funds from the weighted average return of all MPF funds within that specific fund type over the 15-year period.

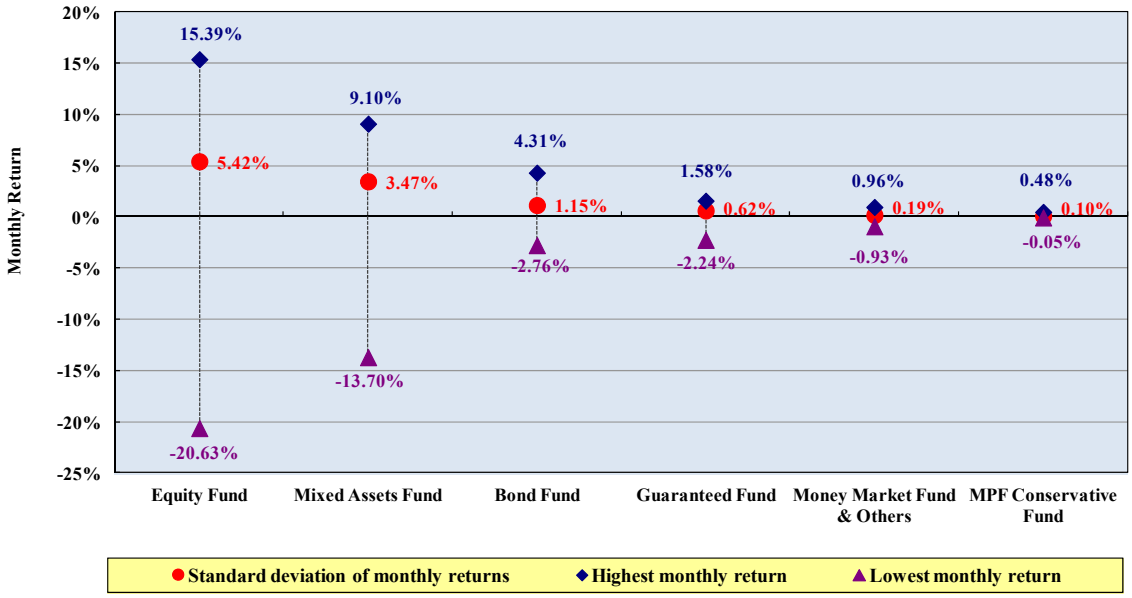
35. An alternative way of expressing risk that has been considered in the review is by measuring the range of monthly returns generated over a period of time. Applied in the current context, a fund type with wider range, that is with returns rising and falling substantially over a certain period, denotes a higher level of risk. Conversely, a fund type with narrower range denotes a lower level of risk.

Risk Levels of Different Fund Types

36. Looking at the risk level from the perspective of standard deviation, among the six types of MPF funds, equity funds indicated the highest level of risk, followed by mixed assets funds, bond funds, guaranteed funds, money market funds & others, and MPF conservative funds (Chart 12).

37. Looking at the risk level from the perspective of range of monthly returns, the results were similar to those based on the analysis of standard deviation. Again, equity funds had the highest level of risk with a range as wide as 36.02 percentage points (monthly returns ranging from -20.63% to 15.39%) within the 15-year period, while MPF conservative funds had a narrow range of 0.53 percentage point (monthly returns ranging from -0.05% to 0.48%).

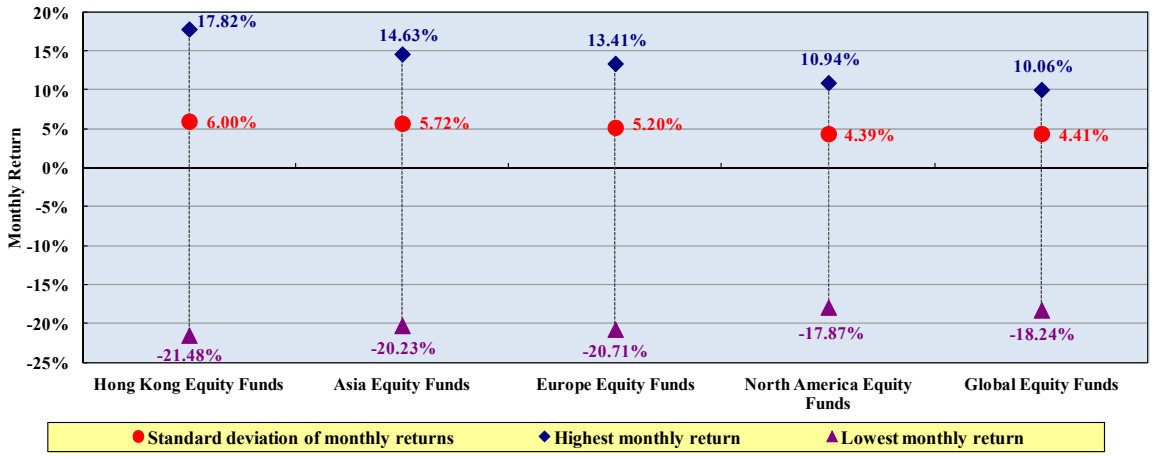
Chart 12 **Standard Deviation, Highest and Lowest Monthly Returns of MPF Funds for the 15-year Period by Fund Type**



Source: MPFA

38. Generally speaking, equity funds with heavy regional equity content (except North America equity funds) tended to have higher risk (6.00%, 5.72% and 5.20% standard deviation for Hong Kong, Asia and Europe equity funds respectively) than equity funds with a global equity content (4.41% standard deviation). During the review period, the volatility of North America equity funds tended to be lower than other regional funds. The risk levels between North America equity funds and Global equity funds were relatively close to each other as Global equity funds usually have high exposure to the North American equity markets (Chart 13).

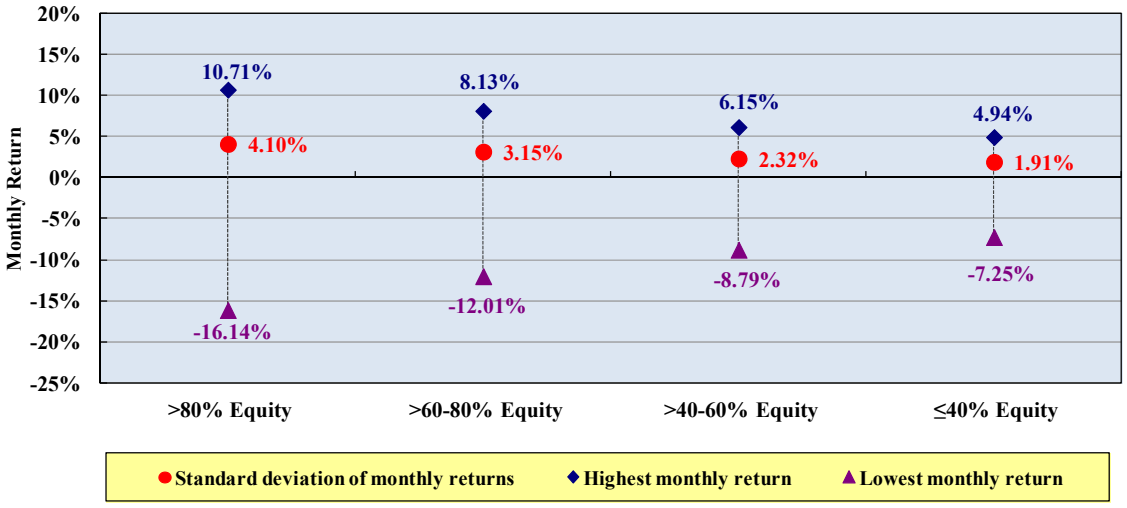
Chart 13 Standard Deviation, Highest and Lowest Monthly Returns of Equity Funds by Region



Source: MPFA

39. Mixed assets funds with higher equity content tended to have greater risk (4.10% standard deviation for mixed assets funds (>80% equity)) compared to those with lesser equity content (1.91% standard deviation for mixed assets funds (≤ 40% equity)) (Chart 14).

Chart 14 Standard Deviation, Highest and Lowest Monthly Returns of Mixed Assets Funds by Percentage of Equity Content



Source: MPFA

Box 3: Relationship between Fees and Investment Performance of MPF Funds

Some may be of the view that funds with higher fees might be able to deliver relatively higher return. To explore if there is any relationship between fees and investment performance of MPF funds, the Fund Expense Ratio ("FER"), which is a ratio that measures the fees and charges of an MPF fund as a percentage of the net asset value of the fund, is plotted against the 15-year annualized return of each fund of the same fund type.

Chart 15 FER vs 15-year Annualized Return

Chart 15a Equity Fund

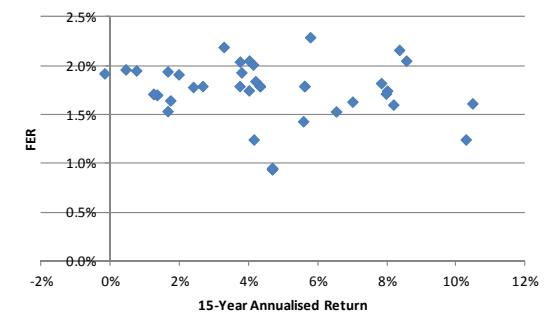


Chart 15b Mixed Assets Fund

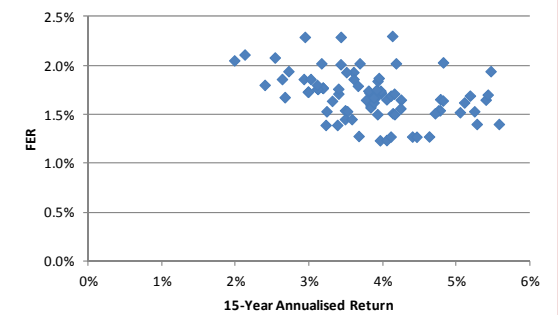


Chart 15c Bond Fund

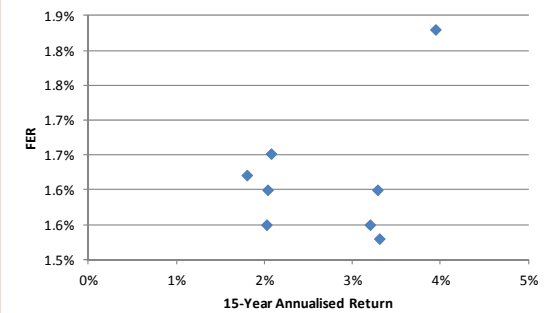


Chart 15d Guaranteed Fund

Chart 15e MPF Conservative Fund

Based on graphical observations, the relationship between FER and long-term investment performance is not conclusive. Some funds with higher FER exhibit lower return than those with lower FER, and vice versa. To investigate further the relationship between fee levels and returns of MPF funds, the Pearson correlation test is applied to each type of MPF funds.

Correlation between FER and Investment Performance of Constituent Funds by Fund Type

H_0: There is no association between FER and 15-year investment performance

Fund Type	Correlation Coefficient	p-value	Decision
Equity Fund	-0.1467	0.3539	Do not reject H_0
Mixed Assets Fund	-0.3953	0.0002	Reject H_0
Bond Fund	0.3690	0.3683	Do not reject H_0
Guaranteed Fund	-0.2747	0.2046	Do not reject H_0
MPF Conservative Fund	-0.6665	0.0001	Reject H_0

Decision rule: reject H_0 if p-value<0.05 significance level

For equity funds, bond funds and guaranteed funds, the hypothesis that there is no association between FER and 15-year investment performance is not rejected. These findings suggest that there is generally no association between FER and 15-year investment performance for funds of these three fund types.

For mixed assets funds and MPF conservative funds, the null hypothesis is rejected and a negative coefficient is recorded for each of them. These findings suggest that the 15-year investment performance is negatively correlated with FER, meaning that funds with higher FER are associated with lower return over the 15-year period and vice versa.

Constraints and Limitations

The above analysis is subject to the following limitations and constraints:

- Owing to the absence of FER figures for the entire 15-year period, the analysis is based only on the FER figures published in November 2015.
- The analysis only covers those MPF funds in operation for 15 years, and excludes all other funds with shorter history.
- The sample size of each fund type covered for analysis is small (particularly in the case of bond funds), which may undermine the reliability of outcomes of the statistical test.

CHAPTER 5 IMPLICATIONS AND CONCLUDING REMARKS

MPF Returns Should be Considered over the Long-Term

40. The results of the review show that the investment performance of the MPF System, recorded substantial fluctuations during the review period. MPF is a long-term investment, spanning across a period of more than 40 years. The investment performance of the MPF System during the period will inevitably be affected by the cycle of financial markets which can in some cases be quite extreme. Depending on the timing of their need to access accrued benefits, members should not be overly concerned with short-term return fluctuations.

41. Despite experiencing significant downturns of the global economy and financial markets throughout the 15-year period, including the outbreak of the SARS in 2003, the global financial crisis in 2008 and the sharp decline of the local equity market in the second and third quarters of 2015, the MPF System demonstrated resilience over the past 15 years.

Strong Relationship between Risk and Return

42. The findings of the review are in line with a fundamental concept about investment: the higher the expected return, the higher the associated risk. MPF funds have generally exhibited this expected relationship between risk and return. Members who want better prospects of higher returns over the long term should not expect to be able to do so without facing higher risks in the form of greater volatility of returns over time.

43. Equity funds and mixed assets funds produced higher returns than other fund types but were also shown to be much riskier than other fund types when measured on the basis of the standard deviation or range of returns. By contrast, those MPF funds that have exhibited lower levels of volatility (such as MPF conservative funds and money market funds & others) have produced substantially lower returns in the 15-year period.

44. As is also illustrated in parts by the investment results of the different types of MPF funds with different degrees of diversification between asset classes, geography and issuers, risk may be reduced by means of a diversified portfolio. The review suggests that diversification across regions or asset classes tends to lower investment risk. An important factor to consider is the correlation between asset classes and market; a low correlation would suggest higher potential for diversification benefits. For instance, equity funds investing only in Hong Kong and Asia recorded substantially higher

volatility (measured by the standard deviation of monthly return) than those more diversified global equity funds over the 15-year period. Similarly, mixed asset funds, which are more diversified than equity funds by investing also in bonds, exhibited lower volatility than equity funds as a whole.

Saving Outcome Hinges on Members' Investment Decision

45. Under the MPF System, all members can choose the investment funds. The implementation of the Employee Choice Arrangement[6] in 2012 has further strengthened members' right of fund choice. The fund choice made by members has an important impact on their saving outcomes. As illustrated at length in this report, different types of funds have generated very different levels of returns at different times. In choosing MPF funds within schemes, members should choose those appropriate for their risk tolerance level and personal circumstances.

46. In considering their risk tolerance level, members need to balance the potential discomfort of volatility against the prospect of longer-term gain. On the one hand, volatility of outcomes can be quite significant – as high as a one-month loss of 20.6% to a one-month gain of 15.4% for equity funds as a group (and even higher for individual funds). On the other hand, investment in lower-risk funds can lead to significant underperformance against other fund types over the longer term. For instance, the cumulative return of equity funds amounted to 83.0% over the 15-year period, while that of money market funds & others was only 8.8%. Expressed in another way, equity funds returned, on average, more than nine times as much as money market funds and others over the review period.

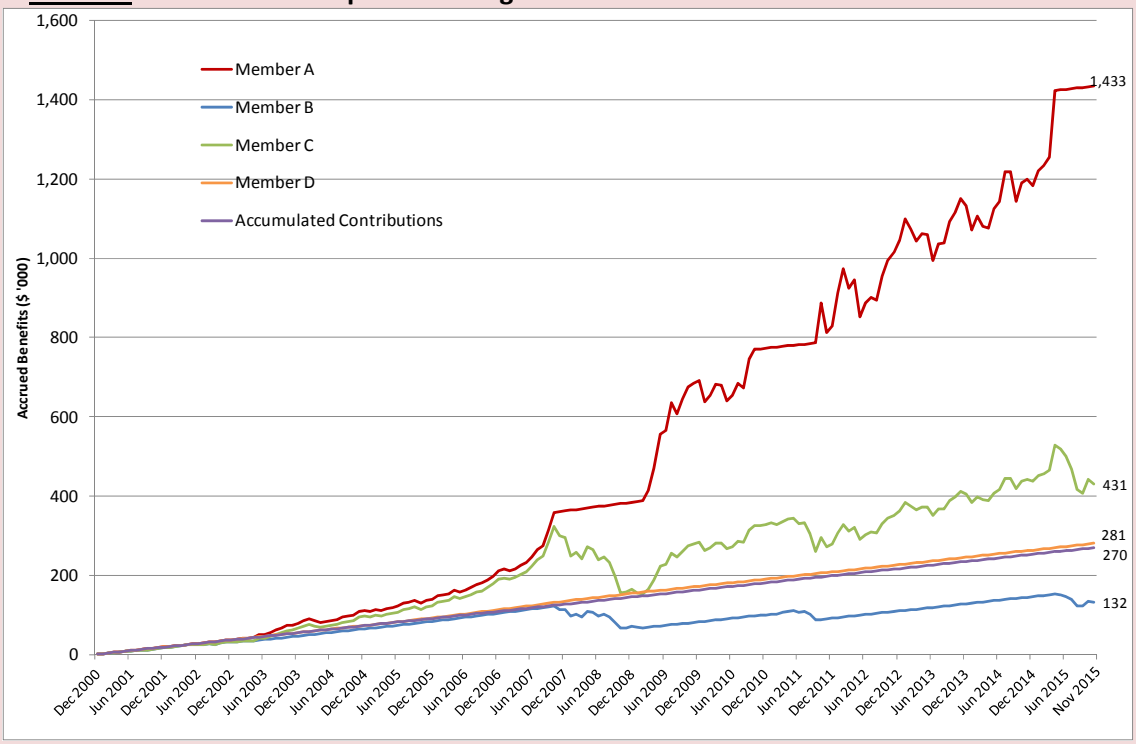
Box 4: Investment Decisions and Saving Outcomes

Members' investment decisions have a great impact, which can be positive or negative on the outcome of their MPF savings. Four hypothetical cases are provided to illustrate this. The first two cases show the extreme saving outcomes of two members who timed the market; one successfully and one unsuccessfully. The use of these hypothetical case studies is not intended to suggest that members should try to time market turning points, but merely to illustrate the potential impact of investment decisions. The market moves in these cases are made with hindsight knowledge of historical return data. In real life, future performance cannot be predicted with any certainty. Some analysis suggests that investors who try to time market movements are more likely to make bad decisions than beneficial ones. The remaining two cases demonstrate the saving outcomes of two members who keep investing in a particular

[6] Under the Employee Choice Arrangement, members have the right to transfer the accumulated MPF benefits attributed to their own mandatory contributions to a scheme of their own choice at least once every calendar year.

fund over the review period.

Chart 16 Illustrative Examples of Saving Outcomes



Assumptions:

(i) Commencement of Monthly Contribution: December 2000

(ii) Monthly Contribution Amount: $750 from member and $750 from employer (based on the median salary of $15,000 per month as at September 2015)

(iii) Rate of Return: Average rate of return of the particular fund/sub-fund types during the period

(iv) Total Amount of Contribution over 15 Years: $270,000

Note: These are hypothetical examples for illustration purposes. All values indicated in the above chart are for illustrative example only.

- **Member A – the successful market timer**: This hypothetical case assumes that a member invested his MPF contributions in an MPF conservative fund 15 years ago. In early 2003, he switched to a Hong Kong equity fund. In late 2007, he switched his MPF investment to an MPF conservative fund. In early 2009, he again switched his MPF investment to a Hong Kong equity fund. In late 2010, he switched his MPF investment to an MPF conservative fund. In late 2012, he switched his MPF investment once again to a Hong Kong equity fund. At the onset of the market tumble in May 2015, he retreated from higher risk assets to an MPF conservative fund. After 15 years of investment, the MPF accrued benefits of this hypothetical "lucky" market timer would have been about $1,433,000, more than five times of his aggregate contributions (i.e. $270,000).

- **Member B – the unsuccessful market timer**: This hypothetical case assumes that a member made market timing decisions in the opposite direction as Member A in respect of the re-allocation of MPF assets between Hong Kong equity fund and MPF conservative fund. After 15 years, the accrued benefits in the MPF account of this hypothetical "unlucky" market timer would have been only around $132,000, less than his total contributions by around $138,000.

- **Member C – the long-term Hong Kong equity fund investor**: This hypothetical case assumes that a member chose a Hong Kong equity fund for investment of his MPF contributions 15 years ago and did not change investment decision at any point. After 15 years, the accrued benefits in his MPF account would be about $431,000, exceeding his total contributions by more than $161,000.

- **Member D – the long-term conservative fund investor**: This hypothetical case assumes that a member chose an MPF conservative fund for investment of his MPF contributions 15 years ago and did not make any change in fund choice during this period. After 15 years, the accrued benefits in his MPF account would be about $281,000, marginally more than his total contributions.

47. Generally speaking, with a longer investment horizon, younger members are in a better position to invest a greater portion of their MPF investments in equity funds and mixed assets funds to capture the potentially higher long-term returns if they are prepared to accept the resultant volatility. By contrast, older members who are close to retirement might consider reducing equity exposure because short- or medium-term periods of negative returns could substantially affect the accrued benefits they intend to access in the short- or medium-term. Building on these implications, the MPFA has proposed a new, standardized, default investment strategy that, amongst other attributes, will automatically reduce risk as the member approaches age 65. It is expected that the default investment strategy will be implemented by the end of 2016.

The Overall System Return Relating Closely with Members' Collective Choices

48. The investment performance of the MPF System as a whole relates closely with members' collective choices. Members' fund choices, put together, have a substantial impact on the overall asset allocation of the MPF System, including the investment markets that MPF assets would be invested in. A salient characteristic of members' collective choices is the dominance of Hong Kong and other Asian markets in the overall allocation of MPF assets (including equities, debt securities and currencies). As a result of members' preferences, the outcomes in the financial markets in Hong Kong and other Asian markets weighed heavily on the investment performance of the MPF System during the review period.

49. The return of the MPF System is often compared with some common benchmarks such as the TraHK. It should however be noted that the MPF System comprises not a single fund but a range of funds with different investment objectives. The asset allocation of the MPF System is, therefore, mixed and varied, unlike the TraHK, which puts the focus on Hong Kong equities only. Given each asset class has its unique risk and expected return

characteristics, comparing the performances of two portfolios with different asset allocations and investment objectives will not be meaningful.

Looking at Past Performance with Care

50. Members are reminded that the return figures set out in this report are only intended to give a generalized indication of the progress of the MPF System and the relationship between risk and return. The return and risk profile of an MPF fund can change over time in accordance with changing economic and market conditions. The fund-type figures set out in the report should not be seen as providing any firm indicator for predicting future absolute performance of MPF funds. As reflected in the report, they may however be somewhat indicative of reasonable expectations about the relative risk and return attributes of different fund types.

51. Members should not make fund choice decisions solely based on short or even medium-term historical performance. Other relevant factors such as suitability of the individual MPF funds for their own circumstances, fees and charges, and quality of services, need to be considered. Members may make use of the Fee Comparative Platform on the MPFA's website to compare the Fund Expense Ratio, On-going Cost Illustration, Fund Risk Indicator and investment returns and select MPF funds that are suitable to themselves in terms of fees and risk level. Moreover, when making comparison, members should only compare the funds under the same fund type. Members should note that past performance is not indicative of future performance.

Appendix A

Features and Categorization of Different Types of MPF Funds

General Features of Different Types of MPF Funds

Fund Type	Investment Objective	Investment Instrument	Risk Level	Major Risk	Points to Note
Equity Fund	To achieve capital appreciation and a return higher than inflation over the long term	Stocks	Relatively high	Stock market volatility, exchange rate fluctuation and overall conditions of listed companies	• There are usually three types of equity funds: single market, regional market or global market. • They invest mainly in stocks listed on stock exchanges approved by the MPFA.
Mixed Assets Fund	To achieve capital appreciation over the long term through investing in a combination of stocks and bonds with risk profile depending on the proportion of stocks and bonds invested by the fund	Stocks and bonds	Medium to high	Stock market volatility, interest rate fluctuation, exchange rate fluctuation, bond credit ratings and credit risk	• Different mixed assets funds have different proportions of stocks and bonds. In general, a greater proportion of stocks is associated with a higher risk.
Bond Fund	To earn stable income from interest and coupon rate and make profits from bond trading	Bonds	Low to medium	Fluctuations in interest rates, exchange rates, bond credit ratings and credit risk	• The bonds must meet the minimum credit rating or listing requirements prescribed by the MPFA.

Fund Type	Investment Objective	Investment Instrument	Risk Level	Major Risk	Points to Note
Guaranteed Fund	To provide a guarantee on the capital invested, or to achieve a guaranteed rate of return	Bonds, stocks or short-term interest-bearing money market instruments	Relatively low (but also depends on the guarantee conditions)	The guaranteed rate of return may be modified with prior notice. If the assets of the guaranteed fund are invested in an insurance policy, the fund may be exposed to the credit risk of the insurance policy issuer.	• A guaranteed fund provides some form of guarantee to scheme members investing in the fund, usually on the capital invested or on a minimum rate of return. • To qualify for the guarantee, all guarantee conditions such as minimum investment period and withdrawal requirements must be met.
MPF Conservative Fund	To earn a rate of return similar to the Hong Kong dollar savings rate	Short-term bank deposits and short-term bonds	Relatively low	Fluctuation in interest rates	• The law requires that each MPF scheme offers at a minimum an MPF conservative fund. • An MPF conservative fund is a low-risk fund, but its return may not be able to beat inflation and may not even be positive. • An MPF conservative fund may be described as a money market fund in the Fund Fact Sheet issued by trustees.

Fund Type	Investment Objective	Investment Instrument	Risk Level	Major Risk	Points to Note
Money Market Fund	To earn a rate of return comparatively higher than that of bank deposits or short-term certificates of deposit	Short-term interest bearing money market instruments such as short-term bank deposits, government bills or commercial papers	Relatively low	Fluctuations in interest rates and exchange rates	• A money market fund is a low risk fund, but its return may not be able to beat inflation or may not even be positive.

Categorization of MPF Funds

1. The categorization of MPF funds was mainly based on the fund type as specified under the Fund Descriptor in the latest Fund Fact Sheet of the relevant scheme.

2. For further analysis:

   (a) Equity funds were classified into five sub-types, namely, Asia, Europe, Global, Hong Kong and North America equity funds.

   (b) Mixed assets funds were classified into four sub-types, namely, ≤40% equity, >40-60% equity, >60-80% equity and >80% equity.

   (c) Bond funds were classified into two sub-types, namely, Hong Kong and Global bond funds.

Appendix B

Methodology – Calculation of Return

Return of MPF System

1. The return of the MPF System is calculated by way of the **internal rate of return** ("IRR"), a method commonly known as dollar-weighted return. The IRR method, which takes into account the amount and timing of contributions into and benefits withdrawn from the MPF System, is used for the calculation of the return of the MPF System as it better reflects the feature of cash inflow and outflow of the MPF System.

2. The monthly internal rate of return of the MPF System ("MIRR") is the discount rate that equates the net present value of all the net monthly contributions made to the MPF System within the review period to the net present value of the accrued benefits at the end of the period.

$$NAV_B + \sum_{i=0}^{n-1} \frac{CF_i}{(1+MIRR)^i} = \frac{NAV_E}{(1+MIRR)^n}$$

Where NAV_B : Net asset values of the MPF System at the beginning of the period

n : Total number of months

CF_i : Net monthly contributions made to the MPF System, i.e. sum of contributions received and benefits transferred from other schemes minus sum of benefits paid out from the MPF System in month i

$MIRR$: Monthly Internal Rate of Return of the period

NAV_E : Net asset values of the MPF System at the end of the period

3. Assumption: All the net monthly contributions made to the MPF System occurred at the beginning of the month.

4. The annualized dollar-weighted return for the MPF System is calculated by raising the MIRR to the power of 12:

$$\textit{Annualized Internal Rate of Return} = (1+MIRR)^{12} - 1$$

Return of Different Types of MPF Funds

5. The returns of different types of MPF funds are calculated by way of the time-weighted method. The time-weighted method takes into account the unit price and asset size of each MPF fund at different points in time. Unlike the IRR method, it does not capture the impact of the contributions into and benefits withdrawn from MPF funds.

6. The **investment return** ("IR") of an MPF fund for month *t* is calculated by dividing the difference between the unit price of the MPF fund at the end of month *t* and the unit price of the MPF fund at the end of the previous month *t-1* by the unit price of the MPF fund at the end of the previous month *t-1*.

$$IR_t = \frac{P_t - P_{t-1}}{P_{t-1}}$$

where

IR_t : Return of the MPF fund for month *t*

P_{t-1} : Unit price of the MPF fund at the end of month *t-1*

P_t : Unit price of the MPF fund at the end of month *t*

7. The **NAV-weighted monthly return** of MPF funds by type is calculated by dividing the sum of the product of the return of each MPF fund and its net asset value of the same type for a specific month by the net asset value of all of the MPF funds of the same type of the same period.

$$IR(type\ A)_t = \frac{\sum_{i=1}^{n(typeA)} NAV_{(t,i)} \times IR_{(t,i)}}{\sum_{i=1}^{n(typeA)} NAV_{(t,i)}}$$

where

$n(type\ A)$: Number of MPF funds grouped under *type A*

$NAV(t,i)$: Net asset value of the i^{th} MPF fund grouped under *type A* at the beginning of month *t*

$IR_{(t,i)}$: Return of the i^{th} MPF fund grouped under *type A* of month *t*

8. The **cumulative return** ("CIR") of MPF funds by type for any period (totally *N* months) is calculated by the geometric link of the NAV-weighted monthly returns of the MPF funds within the same type for the period.

$$CIR(type\ A) = \prod_{t=1}^{N}(1 + IR(typeA)_t) - 1$$

where

IR(type A) : NAV-weighted monthly return of the MPF funds grouped under *type A*
N : Total number of months

9. The **annualized return** ("AIR") of MPF funds by type for any period is calculated by adjusting, on an annualized basis, the cumulative return of MPF funds within that specific type for the period.

$$AIR\ (type\ A) = \sqrt[12/N]{1 + CIR\,(type\ \ A)} - 1$$

where
AIR(type A) : Annualized return of the MPF funds grouped under *type A* for the period
CIR(type A) : Cumulative return of the MPF funds grouped under *type A* for the period
N : Total number of months

Adjustments

10. Due to data limitations, the following adjustments were made in deriving the returns of certain MPF conservative funds and guaranteed funds:

(a) MPF Conservative Funds

During the review period, several MPF conservative funds charged fees via deduction of units. The return figures for these MPF conservative funds had been adjusted to eliminate, as far as possible, any errors caused by charging fees via deduction of units.

(b) Guaranteed Funds

For those guaranteed funds without a unit price, the declared rates of return were used as the returns for the funds.

Appendix C

Methodology – Risk Measurement

Standard Deviation of Monthly Returns

1. **Standard deviation** is used as the measurement of risk. Standard deviation measures how closely a set of values is clustered around the average of those values. If a set of values is close to the average of those values, the standard deviation is said to be low (a figure closer to zero). On the other hand, if a set of values is spread across a greater range, the standard deviation is said to be high (a figure further away from zero).

$$SD(type\ A) = \sqrt{\frac{\sum_{i=1}^{N} (IR(typeA)_i - \overline{IR(typeA)})^2}{N}}$$

where

$SD(type\ A)$: Standard deviation of monthly returns of the MPF funds grouped under *type A* for the period

$IR(type\ A)_i$: NAV-weighted monthly return of the MPF funds grouped under *type A* of month *i*

$\overline{IR(type\ A)}$: Simple average of the NAV-weighted monthly returns of the MPF funds grouped under *type A* over the period

N : Total number of months

Range of Monthly Returns

2. The **range** of monthly returns of the MPF funds by type for the period is calculated by taking the difference between the highest monthly return and the lowest monthly return over the period.

$$Range[IR(type\ A)] = Max[IR(type\ A)] - Min[IR(type\ A)]$$

where

$Range[IR(type\ A)]$: Range of the MPF funds grouped under *type A* for the period

$Max[IR(type\ A)]$: Highest monthly return of the MPF funds grouped under *type A* for the period

$Min[IR(type\ A)]$: Lowest monthly return of the MPF funds grouped under *type A* for the period