Subadditivity in Resource Allocation: An Experimental Study of the Hong Kong Mandatory Retirement Protection Scheme

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Abstract

This paper investigates the effect of subadditivity on how individuals allocate their savings to the Mandatory Provident Fund (MPF) scheme. Findings indicated that when an MPF category is unpacked into its subcategories, individuals tend to allocate a higher percentage of their savings to that fund and that the perceived readiness of fund comprehension mediated the relationship between unpacking and people's allocation. One major contribution is that decision makers' choices of MPFs depend on how the information is presented to them.

Key words: subadditivity; resource allocation; mandatory provident fund; mandatory retirement protection

JEL classification: C91; D81; I31

1. Introduction

People often invest in stock markets and/or funds in order to accumulate and increase their wealth. Focussing on the Hong Kong market, there has been an increasing trend of the percentage of adult population investing in the Hong Kong stock market, from 16.0% in 1999 to 35.0% of the adult population (or 2.07 million individuals) in 2009 (Hong Kong Exchange and Clearing Limited, 2010).

Recently, many people have invested in different types of investment products on a voluntary basis (e.g., collateralised debt obligation, investment-linked insurance, equity-linked instruments, investment-linked savings) or on a mandatory basis (e.g., retirement saving plans imposed by the government). In 2013, there were 1,847 authorised retail funds with a total net asset value of USD 1,237.6 billion in Hong

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Kong, compared to only USD 25.5 billion in 2000 (Hong Kong Investment Funds Association, 2013; Securities and Futures Commission, 2001). In this study, we focus on how people in Hong Kong make decisions in their mandatory retirement investment.

Considering the catastrophe that resulted from Lehmann Brothers' mini-bonds in Hong Kong, it is questionable that people are familiar with the financial products of their choice and are aware of the potential losses (Legislative Council of the Hong Kong Special Administrative Region, 2012). According to the information provided by the Hong Kong Monetary Authority, some HKD 20.2 billion worth of Lehmann Brothers' structured products were sold through banks to over 43,700 investors. The consequences may be even more disastrous in the domain of mandatory retirement protection because it spans a long period of time. It is therefore important to consider how people make decisions in their retirement protection investment and how their decisions may be affected by the information provided by financial institutions.

Before proceeding to the development of the retirement protection scheme in Hong Kong, it may be useful to give an overview of retirement protection in other countries. The issue of an aging population has alarmed many developed countries, especially those with populations that have long life expectancies. The United States, United Kingdom, Singapore, and Hong Kong launched different forms of pension or retirement fund schemes. In the US, an individual retirement account (IRA)—a form of individual retirement plan—provides tax advantages for retirement savings. Taxpayers can contribute up to $5,000 a year and reduce their taxable income by the amount of their contributions. On the other hand, the individual saving accounts (ISAs) are designed to provide UK residents with investment and savings opportunities that provide tax relief. UK residents have different ISA investment choices, for example, cash ISA and stock ISA. They may invest in different financial products, such as stocks, bonds, and mutual funds of their choice (HM Revenue & Customs, 2013a, 2013b). Also, people may transfer their ISAs from one manager to another (HM Revenue & Customs, 2013a). Both IRA and ISA schemes are run on a voluntary basis, whereas the retirement protection scheme in Hong Kong and Singapore are mandatory.

1.1 The Development of the MPF in Hong Kong

The Hong Kong Special Administrative Region (HKSAR) government planned to implement the MPF scheme in 1995 (Puidak, 1995). Along with the governments of other developed countries, the establishment of the MPF scheme was driven by the expectation that the percentage of people aged 65 or above would increase from 13% to 30% in 2041 (Yu, 2008). The MPF System was launched in December 2000 and aimed to be a major source of retirement protection. All employees and self-employed persons, aged between 18 and 65, are covered by the MPF scheme. Employers and employees are required to contribute to the MPF scheme monthly with an amount of HKD 1,500 dollars (USD 192) or 5% of the monthly salary, whichever is lower.

The MPF scheme has grown rapidly in economic value. By March 2013, a total net asset amount of HKD 455.3 billion (USD 58.3 billion) was contributed to the MPF System (Mandatory Provident Fund Schemes Authority, 2013). Before the implementation of the MPF System, only about one-third of the Hong Kong workforce had some form of retirement protection. With the MPF System in place, around 84% of the total employed population (or about 2.60 million individuals) is now covered under MPF schemes (Mandatory Provident Fund Schemes Authority, 2013). The fund types available to contributors differ in terms of their risk levels, ranging from low risk to high risk funds. The performance of MPF varied between 0.7% and 4.1% annualised return since December 2000 (Mandatory Provident Fund Schemes Authority, 2013).

The government has undertaken further initiatives to open up the MPF market such that people are now able to choose their desired firms or banks to manage their MPF contributions since November 2012, which is known as the Employee Choice Arrangement. Before the implementation of the Employee Choice Arrangement, employers assigned MPF providers and the number of MPF choices available to employees was usually fewer than 10. Recent statistics have shown that the number of approved MPF choices has now increased to 470 in 2013 (Mandatory Provident Fund Schemes Authority, 2013). It is therefore logical to predict that people in Hong Kong have to make more decisions regarding which MPF provider is suitable and which funds are in line with their investments. How the MPF providers present the available fund choices may come to the fore.

A number of financial institutions offer MPF to Hong Kong employees, among them the Hong Kong and Shanghai Banking Corporation (HSBC) Provident Trustee (Hong Kong) Limited, AIA Company (Trustee) Limited, BOCI-Prudential Trustee Limited, and the Manulife Provident Funds Trust Company. These four financial institutions are the largest four MPF providers as of 2013 in terms of the market share in the MPF market (Gadbury, 2013). Regardless of which financial institution is chosen by the employer, employees are required to choose between type(s) of funds made available by the MPF provider (i.e., the financial institutions of their choice). Subsequently, they make decisions on the distribution of their monthly savings. For example, suppose that Funds A, B, C, D, and E are available from which employees may choose. Employees need to assign a percentage of their savings to each of these funds (i.e., between 0% and 100%); their monthly contributions will accordingly be spent on their fund choices. For example, one employee may want to allocate 40% of his MPF contributions (as well as the employer's) to Funds A and 30% to C and D respectively.

The purpose of this research is fourfold. First, we seek to examine one of the framing effects—subadditivity—that violates expected utility theory, in a MPF allotment task. In particular, this research investigates how this psychological effect may affect the choices Hong Kong employees make in their MPF savings. A second but related hypothesis concerns the mediating effect of perceived fluency on the attractiveness of the fund category. We assume that unpacking a fund category gives additional details that facilitate individuals' comprehension and, as a result, the

particular fund is judged to be more likely to increase in value. In other words, seemingly trivial manipulations in the way in which a fund is presented may have dramatic impact on subsequent decisions. The results from this study may serve to reveal the way in which people are vulnerable to different presentations of fund types. Third, this study examines subadditivity in a more "personal" event than how unpacking "science-related" expenditures influences the public's assessment of national budget allocation in Japan considered in Yokoyama and Nakayachi's (2012) study. Finally, the findings from this research may allow us to provide the HKSAR government with a guideline about how MPF providers should "fairly" present their fund information to the public.

2. The Subadditivity Effect in Probability Judgement

Events can be partitioned into two or more mutually exclusive subevents. For example, the category of deaths from disease can be separated into deaths from diabetes, pneumonia, tuberculosis, or other diseases. The subadditivity effect pertains to separate probability assessments of an event and of the number of its mutually exclusive subevents. A large body of research has shown that subadditivity is common in both nonexpert and expert probability judgements (Macchi et al., 1999; Rottenstreich and Tversky, 1997; Tversky and Koehler, 1994). That is, people's judgements of probability are different when it is presented in different ways. This constitutes a violation of the invariance principle—one of the four assumptions of expected utility theory (von Neumann and Morgenstern, 1944).

Unpacking—breaking down an event into subevents—may lead to an increase or decrease in the perceived likelihood of an event happening. There are two schools of thought.

2.1 Explicit Subadditivity

Some unpacking studies suggest *explicit* subadditivity, which means that the sum of separate probability judgements of mutually exclusive events exceeds the probability judgement for the superordinate category (Brenner and Rottenstreich, 1999; Fox and Tversky, 1998; Rottenstreich and Tversky, 1997; Wright and Whalley, 1983). This pattern of findings is not limited to subjective probability judgements (Mulford and Dawes, 1999; Slovic, 2000). Mulford and Dawes (1999) have shown that people's frequency judgements of personal events can also be subadditive. Slovic (2000), too, suggests that people are subadditive in a frequency allotment task.

2.2 Implicit Subadditivity

Other experiments that depart from typical unpacking findings have demonstrated *implicit* subadditivity, in which a single probability judgement of a superordinate event is greater when the subcases are explicitly stated. Redden and Frederick (2011) suggest that in several instances in which great detail is given to

individuals the corresponding subjective likelihood is reduced. They found that unpacking a categorical event often make an event seem less likely when the details being unpacked are already *highly accessible*. In particular, subjects were expected to be able to compute probabilities in the dice rolling game in their studies. They provide evidence that people naturally associate the concept of likeliness more with simplicity than with complexity.

2.3 Resource Allocation and Subadditivity

Resource allocation is an important area in decision science, which has drawn attention from many researchers. A large body of research focussed on individuals' decisions in probabilistic resource allocation tasks in which individuals decide on the division of lottery tickets among different parties (Roth and Malouf, 1979; Schmidt et al., in press). Other studies on resource allocation emphasised the importance of factors such as perceived fairness, finance expertise, tax rate, social environmental performance, and the level of financial wealth (Dimov et al., 2007; Harris et al., 1982; Hochguertel et al., 1997; Holm and Rikhardsson, 2008; Johansson et al., 2007). Regarding the impact of the number of investment choices on individuals' decisions, research has considered a naive strategy employed by individuals, known as the $1/n$ heuristic. That is, individuals tend to equally distribute their savings to the investment choices available to diversify risk (Benartzi and Thaler, 2001; Benartzi and Thaler, 2007; Huberman and Jiang, 2006). Further, Huberman and Jiang (2006) provided evidence suggesting that some people's decisions followed the conditional $1/n$ rule in 401(k) plans in the US. That is, individuals first choose the funds of their choice and subsequently divide their money equally to these funds.

Before proceeding to our hypotheses, it is vital to discuss the point of departure between the current research on subadditivity in the MPF and studies of the $1/n$ heuristic. First, the theoretical foundations of the subadditivity effect and the $1/n$ heuristic are very different. The subadditivity effect pertains to the violation of rationality. For example, one's judged probability of death from cancer should not be higher than the sum of separate probability assessments of death from different types of cancer. This violates the assumption of invariance. The $1/n$ heuristic, on the other hand, describes some individuals' investment behavior. When more choices of an investment category (e.g., bonds) are included in an investment menu, individuals adopting the $1/n$ heuristic equally distribute their money to these choices, resulting in higher investment in this category. The increase in investment does not necessarily violate the choice of rationality.

Second, our study considers subadditivity in the MPF decisions for which a *composite* MPF type is unpacked into its *component* MPF types. As will be discussed later, in this study, we investigate the effect of breaking an equity fund into specific equities in different countries. However, research on the $1/n$ heuristic has examined the impact of increasing investment choices that are *not* mutually exclusive and are *not* component types of one another. For instance, Benartzi and Thaler (2007) increased the investment menu by offering growth equity, index

equity, conservative equity income, insurance contracts, bonds, and so on. In their experimental study, one company's stock (e.g., Apple Inc. or Coca-Cola) may be a component part of both conservative equity income and index equity. And, insurance contracts may include bonds, equity, and other financial derivatives that insurance companies think relevant and appropriate. Finally, another important difference is that studies of the $1/n$ heuristic focus on voluntary retirement protection but this study examines differences in individuals' behavior in mandatory retirement protection. It is premature to conclude whether people's decisions may suffer the same bias in mandatory and voluntary retirement investments. And, we do not know much about how people allocate their regular savings to different investment choices and whether their decisions are affected by the presentation of investment options. Specifically, this research focuses on people's decisions in the MPF scheme and examines whether contributors' decisions are subadditive. The post-hoc analyses will discuss our current findings showing that individuals did not appear to adopt the $1/n$ heuristic in the MPF scheme.

Little research on subadditivity in resource allocation tasks has been conducted. The only research that documented examples of subadditivity in resource allocation was Yokoyama and Nakayachi's (2012) study. They considered how unpacking "science-related" expenditures influences the public's assessment of national budget allocation in Japan. This study differs from Yokoyama and Nakayachi's (2012) in several ways. First, the context in question is different. Second, the MPF allotment task considered in this study is directly related to the allocation of decision makers' own savings rather than government or third party resources that people may not ultimately influence. The event studied in this research is more "internal" and "personal."

2.4 Subadditivity and the MPF Allotment Decision

Although the MPF scheme has been launched for over ten years, how people's decisions may be manipulated is still underexplored (Wong, 2014). This study aims to examine whether and how different presentation of a fund type elicits higher percentages allocated by MPF contributors. Unlike those studies suggesting that unpacking leads to a reduction of subjective probability, we have selected events that are not readily enumerated. It is therefore expected that people's decisions in MPF investments demonstrate explicit subadditivity. Specifically, we postulate that, in the domain of the MPF, unpacking a particular type of fund may remind individuals of an investment option they would otherwise ignore or change their construal of that fund.

Past research on subadditivity has primarily focussed on probability judgements and has not yet been applied to the issue of resource allocation. In the MPF allotment task, the total amount of monthly investment can be expressed as 100% and participants can assign a percentage for each fund category (including 0%). It is logical to assume that when one judges a fund to be likely to increase its value on subjective scales, he or she will allocate a high percentage of the monthly

saving to that fund. Owing to this isomorphism, this study sets out to examine whether the subadditivity effect is expected in the MPF allotment task.

2.5 Hypothesis Development

To explore the possibility that people's decisions are subadditive in the MPF allocation, the following hypotheses were tested in this study.

Hypothesis 1a: Individuals allocate a higher percent to the low-risk fund when the low-risk fund is unpacked than when it is not, while the remaining funds are packed.
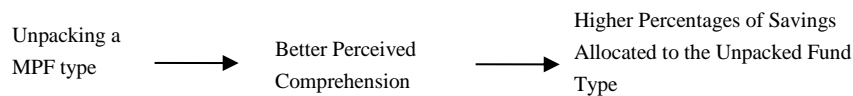
The subadditivity effect has been observed as a general phenomenon that is not expected to be contingent on the perceived risk level of financial products. In other words, it is argued that the subadditivity effect should not be specific to low-risk funds. To fully test the subadditivity effect on people's decisions in their MPF contributions, unpacking the high-risk fund is also considered in another experimental condition and examined separately. That said, to test the following hypothesis, the low-risk fund category remains packed.

Hypothesis 1b: Individuals allocate a higher percent to the high-risk fund when the high-risk fund is unpacked than when it is not, while the remaining funds are packed.

The intuition is that the probability of which fund performs better in the long run is not easily accessible, except for professionals working in the field of finance. Unpacking a fund category provides additional details that increase how readily a fund is interpreted. This fluency increases the perceived likelihood of the fund increasing its value in the future. In other words, when a fund category is unpacked, it increases individuals' perceived feeling of fluency or comprehension. This speculation is consistent with other research showing that more fluent stimuli are judged to be more frequent and believable (Alter and Oppenheimer, 2009; Collister and Tversky, 2000; Rajaram and Geraci, 2000; Whittlesea, 1993). Whittlesea (1993) attempted to frame this effect as *conceptual fluency* and showed that people may be semantically primed to think about certain concepts, which makes them more fluent. In particular, Lee and Labroo (2004) similarly manipulated conceptual fluency by showing that an advertisement of a man walking into a bar makes it easier for people to think about beer in a later task.

To generalise and extend this logic, it may be that people generally find it hard to relate one MPF fund to the investment products. Unpacking a "Fixed Income Fund" as "Asian Bond Fund," "Global Bond Fund," and "MPF Conservative Fund" primes people to consider the financial products under the category of "Fixed Income Fund." We propose that this fluency makes the unpacked fund more attractive. Apart from examining the subadditivity effect, this study also examines how unpacking a fund category may affect how people comprehend the fund type and whether feelings of fluency mediate the relationship between unpacking and subadditivity (see Figure 1).

Figure 1. A Proposed Theoretical Model of Unpacking a MPF Type and Percentages Allocated to Funds

Unpacking a MPF type → Better Perceived Comprehension → Higher Percentages of Savings Allocated to the Unpacked Fund Type

Hypothesis 2a: When the low-risk fund is unpacked, it is judged to be more readily comprehended than when the low-risk fund is packed.

Hypothesis 2b: When the high-risk fund is unpacked, it is judged to be more readily comprehended than when the high-risk fund is packed.

Hypothesis 2c: Perceived fluency mediates the relationship between unpacking and the percent allocation of the fund type.

3. Method

The authors developed an MPF allocation experiment, and this experiment adopted the four major MPF types that most service providers in Hong Kong offer, to strengthen external validity. This experiment paradigm allows for examinations of the effects of unpacking the MPF on subjects' behaviors in MPF contributions. It is expected that subjects in general may interpret different funds differently, and their interpretations are likely to be influenced by memory or experience. To maintain consistency in terms of how subjects perceive the relative risk levels of different funds, an index from 1 to 5 is shown where 1 represents the lowest risk investment option and 5 is the highest risk fund. A similar index has been used by the financial institutions in HKSAR (see, for example, American International Assurance Company (Trustee) Limited, 2012).

3.1 Participants

Subjects were selected from the labor population in Hong Kong—those people who were making MPF contributions at the time of their participation. To ensure validity and representativeness of data, the sample were drawn from different age groups and employees from different industries. Participants were from nine industries, including engineering, banking, academia, consultancy, accounting, retail business, legal, medicine, and the public sector. One hundred and two subjects participated in what was described as a "MPF allotment task." The sample included 57 men and 45 women, with ages ranging from 20 to 53 years and a mean of 27.7 (SD = 8.3) years.

3.2 Procedures

Participants were randomly assigned to experimental conditions and received the general information that described the MPF allocation task on a paper handout before the exercise began. The experimenter provided subjects with specific instructions, details about mandatory provident fund types, the corresponding risk index of funds, and a short quiz to ensure that subjects understood the relative risk levels of different fund types available. The instructions, information, and quiz were given in writing. Subjects were tested individually before taking part in the fund allocation experiment. The experimenter checked answers to every question; subjects in error were told to attempt the question again. Most subjects were correct on their first attempt; all were correct on their second attempts. Subjects were given 30 minutes to complete the MPF allocation task and the post-task questionnaires. The procedure is similar to other experimental studies considering individuals' retirement protection investments (see, for example, Benartzi and Thaler, 2001).

All participants were asked to complete questionnaires at different points of the experiment. The first questionnaire included a number of demographic questions and a risk-attitude test, and it also elicited the participants' perceptions of the risk level of different fund types, which was given before receiving details about the MPF allotment experiment. Another questionnaire given after completing the exercise included questions concerning participants' perceptions of the MPF, fund types available in the task, and their behaviors when making decisions in real-life scenarios. After participants completed the final questionnaire, they were debriefed about the purpose of the experiment.

3.3 The MPF Allocation Task

The simulation used in this study was an allocation task of individuals' mandatory monthly contributions to the MPF. The situation required individuals to decide upon the type(s) and corresponding percent(s) of each MPF type that he or she would invest. Consistent with what have been offered by major financial institutions, there were several MPFs for subjects to choose from. The fund type differed in its nature and corresponding risk level. Subjects could choose to invest their monthly contribution between 0% and 100%, in multiples of 5%, adding up to 100%.

The HKSAR government requires the service providers to offer at least one capital preservation fund—the low-risk investment option—for employees to choose. The experiment included this low-risk fund choice to enhance the external validity of this study (namely "Fixed income fund" in the control group). Overall, there were four main fund choices for the subjects to decide on how much they want to invest their MPF contributions. Other fund types used in this study were those that are commonly offered by MPF providers in Hong Kong (see, for example, American Insurance Assurance Company (Trustee) Limited). The MPF allocation task was originally developed by the authors to mimic how employees decide upon their MPF investment in real-life situations.

3.4 Manipulation Check

Subjects were asked to rate their familiarity of MPF fund choices. As argued, it is unlikely that people are fully aware of the differences among the fund categories. As a result, unpacking any of the fund categories is expected to help accessibility and comprehension of subjects. A seven-point Likert scale was used to assess subjects' familiarity of MPF fund details before the experiment began but after presenting the fund types to subjects. Subjects were asked to indicate to what extent they agreed (or disagreed) with each statement regarding the familiarity of MPF fund choice. 54.5% of subjects revealed that they tended to disagree with the statement "I am familiar with the financial products in MPF."

It is important to check if the perceived risk levels worked as intended and confirm our *a priori* classification. A short quiz was given to subjects before the beginning of the experiment. Subjects were asked "Which of the funds is the most risky investment that may give you the highest return?" and "Which of the funds shown is the relatively least risky option for you?" 96% of subjects gave the correct answers in their first attempt, and the remaining 4% answered correctly in the second attempt.

3.5 Experimental Manipulations

To examine the effects of subadditivity in both low-risk and high-risk MPFs, there were three experimental conditions to which participants were randomly assigned.
1. Packed Condition (Control Group): None of the four MPF categories was unpacked. The funds available were Fixed Income Funds, Equity Fund, Lifestyle Fund, and Dynamic Asset Fund.
2. Low-Risk Unpacked: The Fixed Income Funds were unpacked into Guaranteed Portfolio, Asian Bond Fund, Global Bond Fund, and MPF Conservative Fund. The remaining funds remained packed.
3. High-Risk Unpacked: Only the high-risk fund was unpacked into four sub-categories: European Equity Funds, Greater China Equity Funds, Japan Equity Funds, and Hong Kong Equity Funds. The remaining funds remained packed.

3.6 Measures

3.6.1 Allotments to the Low-Risk Fund and High-Risk Fund

The total value was calculated after the subject completed the task. If the total assignment was not equal to 100%, the subject was asked to make corresponding changes. The response variables were the total percentages invested in the Fixed Income fund (the lowest risk fund type) and the Equity Fund (the highest risk fund type).

3.6.2 Readiness of Fund Comprehension

After finishing the allotment experiment, subjects were required to fill out the questionnaire that tested how readily subjects comprehended the fund categories. To assess whether unpacking fund type facilitated subjects' comprehension of MPF types, we asked them to state the extent of their agreement with the statements illustrated in Table 1. Subjects responded on a seven-point Likert scale (1 = "strongly disagree" to 7 = "strongly agree"). Responses to items 1 and 4 were summed to obtain a score of *high-risk MPF comprehension*, and responses to items 2 and 3 were summed to obtain a score of *low-risk MPF comprehension*.

These measures allowed for examinations of whether unpacking a low-risk fund or a high-risk fund facilitates subjects' comprehension of the content of the fund category such as Fixed Income Fund and Equity Fund.

Table 1. Items for Perceived Fluency of Low-Risk and High-Risk MPFs

1.	The high-risk (equity) funds are easy to understand.
2.	The name(s) of the low-risk fund category gives me enough information to comprehend the fund type.
3.	The low-risk (fixed-income) funds are easy to understand.
4.	The high-risk fund category(-ies) provides me with sufficient information to understand the nature of the fund type(s).

3.6.3 Individual Risk Attitudes

As indicated above, some funds contain relatively higher risks and returns than others, and subjects may differ in terms of their risk attitudes. As a result, risk-seeking individuals prefer the high-risk funds to relatively low-risk funds when allotting their monthly contributions to the MPF investments. In contrast, risk-averse individuals may opt for the low-risk funds. As subjects were randomly assigned to one of the three experimental conditions, the average level of risk attitudes across different experimental conditions should be more or less the same (or the ratios of risk-seeking vs. risk-averse individuals should be more or less the same). It is still important to measure their risk attitudes *prior to* the experiment. This risk attitude test allows for later data analyses by considering the difference in the effects of subadditivity on participants with different risk attitudes.

4. Results

4.1 Allotments to Low-Risk and High-Risk Funds

A one-way analysis of variance (ANOVA) was used to test the relationship between the manipulated levels of fund types and the response variables. No main effects of gender for low-risk MPF and high-risk MPF were found across experimental conditions ($F(2,99) = 2.37$, p = ns; $F(2,99) = 0.44$, p = ns). A series of planned contrasts were performed to compare the percentages of monthly MPF

contributions allocated to low-risk MPF and high-risk MPF across the three experimental conditions.

Table 2. Mean Percentages Assigned to Fund (Standard Deviations) by Experimental Conditions

	Experimental Condition		
	Packed (Control)	Low-Risk Unpacked (Condition 2)	High-Risk Unpacked (Condition 3)
Low-Risk MPF	22.06_a (17.62)	41.76_b (22.69)	17.79_a (24.65)
Guaranteed Portfolio	—	12.79 (11.88)	—
Asian Bond Fund	—	13.82 (12.68)	—
Global Bond Fund	—	9.85 (9.41)	—
MPF Conservative Fund	—	5.29 (7.78)	—
High-Risk MPF	43.08_a (28.55)	25.44_b (15.78)	54.85_c (25.51)
European Equity Funds	—	—	7.94 (11.49)
Greater China Funds	—	—	27.06 (21.71)
Japan Equity Funds	—	—	7.50 (10.39)
Hong Kong Equity Funds	—	—	12.35 (12.38)
Dynamic Asset Allocation Fund	16.32_a (13.89)	17.94_a (12.62)	11.76_a (11.27)

Notes: $n = 34$ in each condition. Subscripting is based on comparisons of means within each row using ANOVA with contrasts; different subscripts indicate means differ at $p < 0.05$ or less (e.g., the mean percentage allocated to low-risk MPF in the control group is given the subscript "*a*" and is significantly different to that for condition 2 given subscript "*b*"). The values of low-risk MPF and high-risk MPF were calculated by adding the percentages allocated given by each participant in Condition 2 and Condition 3 respectively.

Table 2 reports the mean percentages allocated to low-risk and high-risk MPF funds across the three experimental conditions. We compared the percentages assigned to the low-risk funds when the low-risk fund was unpacked to those when it remained packed (Condition 2 vs. control group). According to ***Hypothesis 1a***, the contribution to low-risk funds should increase when this fund category was unpacked. As can be seen in Table 2, when the low-risk fund was explicitly unpacked, subjects tended to assign a larger percent of their monthly contribution to the low-risk fund ($M = 41.8\%$) than when it was not ($M = 22.1\%$), $t = 3.717$, $p < 0.0005$, $d = 0.99$. This indicates that more information available to individuals had a significant, positive impact on their MPF allocation. A significant main effect of

experimental conditions was found for subjects' allocations to low-risk funds, $F(2,99) = 11.634$, $p < 0.0005$, $\eta_p^2 = 0.190$.

The results also support ***Hypothesis 1b*** that when the high-risk fund was unpacked it received greater contributions from subjects ($M = 54.9\%$) than when it was not ($M = 43.1\%$), $t = 2.029$, $p < 0.05$, $d = 0.49$. A significant main effect of experimental conditions was found for subjects' allocations to high-risk funds $F(2,99) = 13.034$, $p < 0.0005$, $\eta_p^2 = 0.208$. Since the Dynamic Asset Allocation Fund with a risk index of 4 may be considered risky, it is important to check if unpacking the high-risk fund impacted contributions to this fund. One possibility is that unpacking the high-risk fund in Condition 3 provided participants with more choices of risky funds (those with risk indices of 4 and 5) in the MPF menu. As shown in Table 2, unpacking the high-risk fund did not alter participants' allocation to the Dynamic Asset Allocation Fund in the three experimental conditions, $F(2,99) = 2.183$, $p = \text{ns}$.

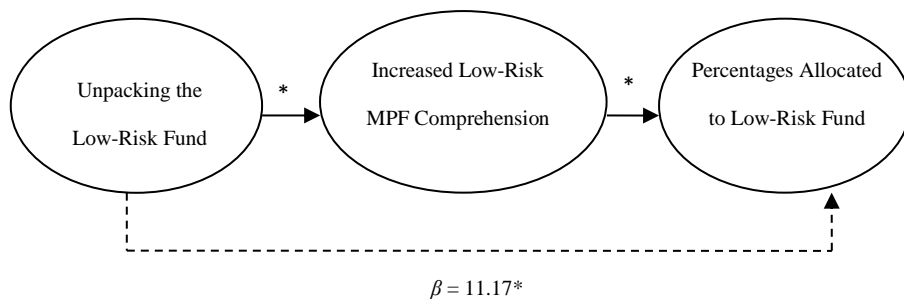## 4.2 Mediating Role of Readiness of Fund Comprehension

As described before, a seven-point Likert scale was employed to assess the degree to which subjects comprehended both the low-risk and high-risk MPFs. Two principal component analyses were performed to examine the dimensionality of the scales for subjects' comprehension of low-risk and high-risk funds. For comprehension of low-risk MPF, the analysis yielded a single dominant component with an eigenvalue of 1.701 that explained 85.0% of the total variance of the score. For comprehension of high-risk MPF, it also yielded a single component with an eigenvalue of 1.619 that explained 80.9% of the total variance. As planned, subjects' responses to items 1 and 4 were summed to produce *high-risk MPF comprehension*; items 2 and 4 were summed to obtain *low-risk MPF comprehension*. Both of these scores showed acceptable levels of internal reliability (Cronbach's alpha = 0.764 and 0.824, respectively).

Hypothesis 2a predicted that when the low-risk fund was unpacked, subjects would find it more readily comprehended than when the low-risk fund was packed. The finding lent support to this hypothesis. When the low-risk fund was unpacked, the mean of low-risk MPF comprehension was higher than when it was not ($M = 9.03$ vs. $M = 6.52$), $t = 4.12$, $p < 0.0005$, $d = 1.10$. ***Hypothesis 2b*** also received support. When the high-risk fund was unpacked, it was judged to be more readily comprehended ($M = 8.12$) than that in the control group ($M = 6.18$), $t = 3.24$, $p = 0.002$, $d = 0.74$.

Hypothesis 2c postulated that feelings of fluency mediated the relationship between unpacking and percent allocation. To test this, linear regressions were performed with four conditions to be satisfied (Baron and Kenny, 1986). The first condition is that unpacking needed to be related to percentages allocated to low-risk and high-risk funds, which were confirmed previously. Second, unpacking needed to be related to low-risk MPF comprehension and high-risk MPF comprehension, which we have illustrated. Third, MPF comprehension needed to be related to percentages allocated to low-risk and high-risk funds while controlling for
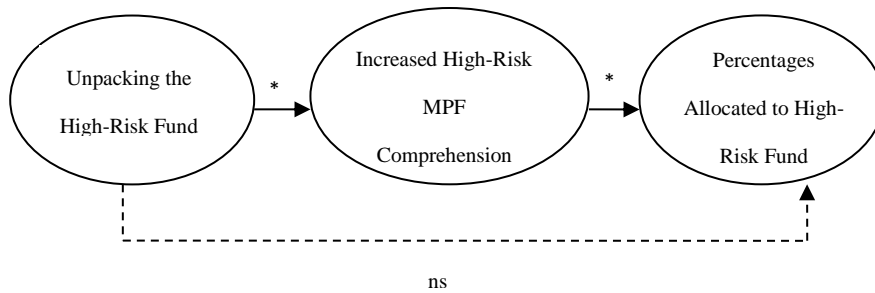
unpacking (see (2) and (4) in Table 3). Fourth, the relationship between unpacking and resource allocation needed to be reduced when taking into account the indirect effect of low-risk MPF comprehension and high-risk MPF comprehension.

Figure 2. Structural Equation of Model of the Relationships among Unpacking a Low-Risk Fund, Perceived Low-Risk MPF Comprehension, and Fund Allocation

$$\beta = 11.17*$$

Note. The dotted line shows the relationship between variables when controlling for low-risk MPF comprehension. * $p < 0.05$.

Figure 3. Structural Equation of Model of the Relationships among Unpacking a High-Risk Fund, Perceived High-Risk MPF Comprehension, and Fund Allocation

ns

Notes: The dotted line shows the relationship between variables when controlling for high-risk MPF comprehension. * $p < 0.01$.

Table 3. Summarised Results of Structural Equation Models

Measures	Percentages Allocated to High-Risk Fund		Percentages Allocated to Low-Risk Fund	
	(1)	(2)	(3)	(4)
Unpacking Low-Risk MPF	—	—	11.17^{*} (5.41)	19.71^{***} (4.93)
Unpacking High-Risk MPF	5.88^{*} (3.28)	1.04 (3.18)	—	—
Low-Risk MPF Comprehension	—	—	3.21^{**} (1.04)	—
High-Risk MPF Comprehension	—	4.48^{***} (1.15)	—	—

Notes: Regression models are presented vertically; numbers across the top of the table in parentheses indicate different regression models, and the labels across the top of the table indicate the response variable for the regressions in the columns below. Entries in the columns are unstandardized regression coefficients, with standard errors in parentheses. $^{*}p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.0005$.

Illustrated in Table 3 are the linear regression models. Regressing percentages allocated to the low-risk MPF on unpacking the low-risk fund, the regression coefficient for unpacking was 19.71 ($p < 0.0005$). However, as can be seen in Figure 2, when regressing percentages allocated to the low-risk MPF on unpacking the low-risk fund and low-risk MPF comprehension, it was found that the regression coefficient for low-risk MPF comprehension was 3.208 ($p = 0.003$), whereas the regression coefficient for unpacking was reduced to 11.17 and it was significant ($p = 0.043$). On the other hand, regressing percentages allocated to the high-risk fund on unpacking and high-risk MPF comprehension, we found that the regression coefficient for high-risk MPF comprehension was 4.480 ($p < 0.0005$) whereas the coefficient for unpacking the high-risk fund was insignificant ($p = $ ns) (see Figure 3). We can conclude that the readiness of MPF comprehension mediated the effect of unpacking on investment allocation.

4.3 Post-Hoc Analyses

Two additional analyses were conducted. The first analysis regards subjects' search for information when making decisions about MPF investments in real-life situations. The findings from a post-task questionnaire revealed that a significant percent of subjects tended *not* to read the details of different MPF types provided by their banks or financial institutions when deciding on which fund(s) they would invest in real-life situations. Specifically, about 61% of subjects reported that they slightly disagreed, disagreed, or strongly disagreed with the statement "I always read

the details of MPF provided by the financial institution," whereas only about 19% tended to agree with this statement.

The second analysis focused on the relationship between unpacking and self-reported risk attitudes. From the risk attitude test assessment, about 55% of the subjects reported that they were risk-averse: They were willing to pay less than the expected value of the wheel of fortune game in the pre-MPF task exercise. The risk-averse subjects were more or less equally involved in the three experimental conditions. One might argue that the risk-averse subjects would be more attracted to low-risk funds that would generate fixed income. When confining to cases where subjects reported being risk averse, the impact of unpacking high-risk fund categories on percentages allocated to the high-risk fund is still statistically significant ($t = 2.056$, $p < 0.05$).

As mentioned earlier, past studies have shown that individuals may adopt a naive approach to reduce their risk exposure. One might argue that the observed higher allocations to unpacked funds in Conditions 2 and 3 stem from participants' approach to divide their savings equally among available MPF choices rather than subadditivity. To rule out this possibility, an examination of the number of participants using $1/n$ or conditional $1/n$ heuristics in MPF allocation is necessary. Out of 102 participants, two participants appeared to evenly allocate their MPF savings to the funds available in the control group (approximately 25% to four available funds). Only two participants in Condition 3 adopted conditional $1/n$ approach: A few funds were chosen among the available choices and savings were evenly distributed to these chosen funds.

5. Discussion

Past research on subadditivity has primarily focussed on probability judgements. We extend the domain to involve allocation of one's own resources rather than judgements of probability. This study is an extension of research on subadditivity to involve allocation of people's own resources in Hong Kong—people's decisions about MPF investments. The findings from this research show that subadditivity exists when individuals decide about how to allocate their savings, which involves personal stakes more directly. Notably, our results are largely consonant with a large body of research showing that unpacking an event into its elemental constituents increases judged likelihood (Brenner and Rottenstreich, 1999; Mulford and Dawes, 1999; Rottenstreich and Tversky, 1997; Wright and Whalley, 1983). And, the unpacking effect is profound regardless of the risk levels of funds. That is, unpacking either low-risk or high-risk funds could lead to higher percentages allocated by individuals. The result from the post-hoc analysis shows that this effect is powerful enough to override individuals' personal risk attitude. Alternatively, it could mean that individual risk attitudes towards MPF investment could be quite different from those in other contexts (e.g., wheel of fortune games).

We propose that the increased processing fluency is due to the greater detail that accompanies implicit delineation of the financial products of a particular MPF. This is because the MPF types usually have relatively vague extensions involving a large number of exemplars that cannot be quickly summoned or computed. The mediation analyses lend support to this conjecture. Individuals tend to believe that one fund type is relatively easier to be understood when being unpacked, resulting in a higher percent being allocated to that fund. The findings are consistent with Tversky and Koehler's (1994) theoretical rationale for subadditivity in probability judgements that different descriptions of the same event may bring people's attention to different aspects of the outcome and increase the relative salience.

Our findings contradict Redden and Frederick's (2011) experimental findings that suggest implicit subadditivity. The discrepancies between our study and Redden and Frederick's (2011) study can be resolved by recognising the effect of unpacking on fluency. For simple tasks, unpacking diminishes fluency. However, in the context of MPF investment, people generally perceive themselves to be unfamiliar with the MPF types made available by the MPF providers. Unpacking MPF categories reduces the perceived complexity of funds. Nonetheless, it is premature to conclude that people make better decisions when the fund types are unpacked, because better decisions in the MPF contribution could mean higher returns of investment. Instead, the results suggest that, in order for contributors to make an informed and fair decision, MPF providers should avoid asymmetric unpacking of MPF categories. On the other hand, MPF contributors are advised to familiarize themselves with the financial products associated with the MPFs of their choosing.

In the current study, we examine the effect of unpacking a fund type in situations where the unpacked fund types are only a subset of the composite fund type. For example, in the high-risk unpacked condition, European, Greater China, Japan, and Hong Kong Equity Funds do not include all types of equity funds available in MPF investments. It therefore begs a question: What would happen if unpacked funds make up the entire set of possible cases of the composite fund? Mulford and Dawes's (1999) findings may help shed light on this issue. They examined subadditivity in memory for personal events and found that subadditivity was more severe if the component events A and B covered the entire possible cases of the composite event C. To extend this logic in the context of MPF contributions, when a fund is unpacked into all of its possible sub-types, people's allocations of their savings to this fund will be even higher than when unpacked funds make up a subset of possible fund types. In other words, if a MPF provider intends to induce more investment in a particular fund type from contributors, it may unpack the composite fund into all of its sub-funds.

As suggested earlier, we have shown that when the high-risk or low-risk fund was unpacked, people tended to allocate more of their savings to the unpacked fund. Yet, one may wonder how people's decisions in MPF allocation to one particular fund type would be affected when the target fund is packed but other alternative funds are unpacked. Although it has not been directly tested in this study, the relationship between unpacking and allocations to low-risk and high-risk funds also

provides us with some insights into this question. When the low-risk fund was unpacked, it was found that the percent allocated to high-risk fund was significantly less than when it was packed (43.1% vs. 25.4%, $t = 3.043$, $p < 0.01$). However, when the high-risk fund was unpacked, the percent allocated to low-risk fund was insignificant. One explanation is that in the control group subjects allocated about 22% of their savings to the low-risk fund and about 43% to the high-risk fund (see Table 2). It is possible that people are not generally attracted to the low-risk MPF and that unpacking other fund categories has little impact on people's allocations to the low-risk fund. Alternatively, this insignificant result may be because the remaining two funds (i.e., Dynamic Asset and Lifestyle Funds) were packed. Our speculation is that when the target fund is packed and the alternative fund categories are unpacked, people would assign less of their monthly savings to the target fund. More research is necessary to confirm this conjecture.

We are uncertain as to how contributors' decisions may be affected when all funds are unpacked. Future research should consider contributors' allocations to different MPF types when MPF categories are symmetrically unpacked. Coupling our results with Yokoyama and Nakayachi's (2012) findings, we speculate that the impact of unpacking a single MPF category is lessened when other MPF categories are also unpacked. That is, when *all* MPF types are unpacked into their composite fund types, individuals may allocate lower percentages to their savings to the focal fund than when *only* the focal fund is unpacked.

The current study also has important practical implications to MPF contributors and the HKSAR government. Although the launch of the MPF scheme has probably created more employment opportunities in the areas of MPF investment management and the promotion of MPF products (Chan, 2003), the government should not underestimate the importance of educating contributors about how to make unbiased decisions and of promulgating regulations on the MPF providers' presentation of information to the public. In particular, the results suggest that when financial institutions present the information of funds differently, they could make a particular fund more attractive to contributors since MPF contributors are vulnerable to how information is being presented. It is possible that different funds vary in terms of their profit margins. If this is true, financial institutions may be inclined to present the fund information differently. The guidelines provided by the HKSAR government, however, emphasize the administrative charges and quality of services of MPF providers (Mandatory Provident Fund Schemes Authority, 2011). More importantly, to our knowledge, there is no rigorous regulation imposed by the HKSAR government about specific or equal amounts of information being provided to MPF contributors. As noted in the post-hoc analyses, we know that individuals are not generally familiar with MPFs and that they tend not to understand the details provided by the MPF providers. Thus, MPF contributors should be aware of their vulnerability, and we urge the HKSAR government to provide guidelines to MPF providers regarding how information should be presented to the public.

6. Conclusion

In this study, we found that unpacking MPF categories can largely affect people's allocation of resources in mandatory retirement protection. We have demonstrated that unpacking a fund type may elicit more allocation of contributors' saving, regardless of the risk level of the MPF.

Although our study was restricted to MPF investments in Hong Kong, our findings may be applied in other situations. As stated in the introduction, we may extend this research to examine whether people's decisions are also subadditive in other investment choices in other countries, such as pension schemes and ISAs in the UK. It would be interesting to compare if there are differences in people's decisions between voluntary and mandatory retirement protection, investments, or savings. This paper moves the field forward by opening several avenues to explore. In future studies, we will clarify other areas in which decisions in resource allocation may be influenced by logically equivalent descriptions that vary in details.

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