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Personal financial planning based on fuzzy multiple objective programming

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Abstract

Personal financial planning involves managing all the money activities during a planner's lifetime. Traditional personal financial planning procedures begin with the planner's financial status, goals, and expectations for the future before future cash flows of different time periods under various scenarios can be determined. If the planning results fail to meet the planner's expectation, the planner adjusts tunable parameters repeatedly until an acceptable financial arrangement can be obtained. Such a "trial-and-error approach" or "what-if analysis" does not promise to achieve the optimal plan while numerous outcomes burden the planner. Multiple objectives with different goals of different importance levels might be involved in this decision-making problem. Since the objectives tend to conflict with each other, this study proposes to solve the problem based on a decision model that incorporates a fuzzy multiple objective programming method to achieve better solutions than using "trial-and-error".

Keywords: Personal financial planning; Mathematical programming; Fuzzy multiple objective programming

1. Introduction

Personal financial planning (Madura, 2002) manages all money activities during a person's lifetime, including maximizing one's wealth, satisfying one's life goals, and managing risks from different sources. Financial planning begins with examining one's personal financial statements, requiring the planner to provide his/her financial status, life goals, risk preferences, and so on. The planner makes a better decision through trial calculations under different scenarios. Such a "what-if" analysis might present difficulties. First, solving the financial planning problem by trial-and-error gives a satisfying suggestion, but not necessarily the best that can be found. Although some numerical analysis methods, such as the goal seeking of Crabb (1999), could be used to find the optimal decision for problems with a single objective, they are unrealistic because personal financial planning often involves multiple decision objectives to be achieved at the same time. Second, the planners might have various preferences for different objectives. Personal preferences regarding objectives should be considered when conducting the analysis. Third, financial goals set by the planner might be flexible. The planner might prefer to provide an acceptable range for a goal instead of an exact value, for example, the lower and upper limits for house price. Finally, as Fortin (1997) have stated, the solution to a financial planning problem might not be in a closed-form.

In view of the above difficulties, mathematical programming appears promising, which motivates this study. Goal programming and compromise programming (Yu, 1985) have a long history in dealing with multiple objective optimization problems. However, they fail to handle flexible goals. The only known method capable of doing this is fuzzy goal programming, but traditional fuzzy goal programming methods cannot incorporate objective weights. Lin (2004) recently proposed a weighted max–min

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Nomenclature

l_0	initial living expense	d'	actual down payment
τ	the time to own a house	m	expected amortization payment
v	the value of the house	m'	actual amortization payment
p	the amount of pension	r_t	expected house rent
$\mathbf{x}$	vector of decision variables	r'_t	actual house rent
$f_i(\mathbf{x})$	objective function	s_t	salary income
$\mu_i(f_i)$	membership function (utility function) of $f_i(\mathbf{x})$	e_t	earning from investment
u_t	0–1 variable signifying the purchase of a house	l_t	living expense
y_t	0–1 variable indicating the ongoing of amortization schedule	A_t	investment position
		b_t	balance
z_t	0–1 variable indicating the cease of amortization schedule	k	annual rate of return
		I	inflation rate
T	financial planning horizon	g_i	goal value for $f_i(\mathbf{x})$
τ	the time to buy a house	$\underline{g}_i$	lower (upper) tolerance for $f_i(\mathbf{x})$
H	loan duration	λ	minimum achieved level among objective goals
d_t	expected down payment	w_i	weight of $f_i(\mathbf{x})$

approach for fuzzy goal programming problems, which method considers objective weights and appears to be the best choice for the personal financial planning problem.

This study formulates a decision model for financial planning that considers the incomes from salary and investment, and the expenses for living, purchasing a house, and raising children. Four objectives are considered, including the level of living expense, the time to buy a house, the value of the house, and the pension available at retirement. All the objectives that contribute to one's life quality before and after retirement are to be maximized except the time to buy a house. The decision model incorporates Lin's method (Lin, 2004) for fuzzy goal programming, so as to consider objective weights, which method is capable of giving more important objectives higher levels of goal achievement than less important ones. Numerical examples are provided to show the effectiveness of the proposed method. The rest of this paper is organized as follows. Section 2 illustrates the personal financial planning problem by an example, and formulates a decision model for that problem. Section 3 discusses methods for fuzzy goal programming, and gives a fuzzy goal programming model for the financial planning problem. Section 4 presents the numerical examples, and finally, Section 5 draws conclusions.

2. Personal financial planning

To illustrate the personal financial planning problem, consider the following scenario.

Mr. Chiang is a 30 years old white-collar worker whose wife is 28 years old. The couple plan to have their first baby after 2 years and have another after 5 years. Mr. Chiang's annual salary is about NT600,000, and Mrs. Chiang's is 400,000. Living expense for this couple is about 450,000 per year, and they pay 200,000 for house rent every year before they have their own house. Their incomes and expenses are expected to increase with the inflation rate, which is estimated to be 2%. They have currently 500,000 in investment with an annual rate of return 5%, and all surplus incomes would be joined to the investment. Each child will increase the living expense by 25% before they are graduated from university at age 22. Mr. and Mrs. Chiang wishes they can possess their own house at a cost of about 8,000,000 in 10 years. Besides the down-payment that is required by the bank to be at least 20% of the house value, they intend to pay the deficit through an amortization schedule of 20 years with an annual interest rate of 8%. The couple plan to retire when Mr. Chiang is 60. The retirement payment will be the double of their annual salaries at that time.

The decision variables that Mr. Chiang can control in this typical personal financial planning problem are assumed to be the living expense, the time to purchase their house, the price of the house and consequently their pension at retirement. Other variables are uncontrollable environmental parameters. The decision they made directly influences the family's overall life quality. The planner wishes to achieve as high living expense, house price and pension as possible, but to own the house as early as possible. The objectives conflict with each other because shortage of cash is not allowed by Mr. Chiang when all expenses must be paid by their liquid assets. For examples, raised living expense gives a better life, but the results are very likely to be delayed house ownership, a cheaper house, or lesser pension at retirement. Consequently, Mr. Chiang is confronting a typical multiple objective decision-making problem. A trial-and-error method might be helpful, but it is very exhausting. Besides, the optimal solution might never be found. Mathematical programming appears to be the only way of solving this financial planning problem. However, a model for this problem must be built before a mathematical programming method can be used to solve the problem.