Evaluating the Effect of Introducing 529 Plans in Japan using Multi-Period Stochastic Programming Model

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1. INTRODUCTION

In recent years, the cost of children's school fees has put pressure on household budgets in Japan. This is because the average cost of college tuition has increased by 1.25 times over the past 25 years, whereas the average annual household income has remained at 0.98 times. One of the methods currently used in Japan to prepare for educational expenses is educational insurance. However, this method offers relatively low returns, and it is vulnerable to inflation because the terminal benefits are fixed and do not increase with rising prices. On the other hand, in the U.S., there is an investment-based education funding system called a 529 plan. 529plans utilize investment trusts and ETFs to earn tax-free investment income. Investments in stocks are generally inflation resistant. Thus, 529 plans, which are primarily based on such investments, are effective in addressing future increases in tuition costs. In this paper, we propose a model of household financial plan for education and quantitatively evaluate the effect of introducing 529 plans in Japan. We employ the framework of the multi-period stochastic programming approach proposed by Hibiki (2011) with the CVaR (Conditional Value at Risk) measure. As in previous works, Ma and Foore (2002) evaluated 529 plans without household uncertainties such as mortality and changes in school destinations. In contrast, the proposed model enables us to analyze the plans under such uncertainties. We compare two scenarios: one in which education funds are provided solely through 529 plans, and another in which they are provided solely through educational insurance. The result reveals that for households with annual incomes between 3.5 and 6 million yen, 529 plans outperform educational insurance in terms of both expected terminal wealth and CVaR. The advantage of 529 plans becomes increasingly significant as tuition costs rise. The impact on government finances is also analyzed. The Japanese government offers an educational support program that provides tuition reductions and scholarships to households with financial difficulties in paying college tuition. If tuition inflation continues, it is expected that the educational support program will be expanded, and more government budget will be needed. Therefore, we compared the fiscal burden of developing the educational support program with the tax revenue loss resulting from the introduction of 529 plans in Japan. The results suggest that, over the long term, introducing the 529 plan may be more effective in reducing the fiscal burden than developing the educational support program.

2. METHOD

This paper develops a multi-period stochastic programming model to compare 529 plans with educational insurance as methods for financing education. The model is evaluated by simulating 10,000 future scenarios of the assumed household's uncertainty and optimizing across these simulation paths. The assumed household consists of a married couple and one child. Incomes include wages, survivor pensions, life insurance benefits, and educational insurance. Expenditures include consumption and non-consumption expenditure items in the Ministry of Internal Affairs and Communications' household survey (2023), life insurance premiums, and educational insurance premiums. We assume that the only householder works and may die during the planning period. The household aims to save enough money for their child until enrolling in college by utilizing a 529 plan and educational insurance. We determine both the total amount of educational insurance benefits to be received by the time the child graduates from college, and the asset allocation strategy to risky assets at each time. Additionally, it is assumed that no withdrawals are made from the 529 plan account except for college tuition. The objective function is set using the CVaR measure of terminal wealth, allowing the household to manage downside risk with respect to the terminal wealth distribution and prepare funds for the future. We then formulate equations at each time to calculate wealth and rebalance assets under the 529 plan as constraints. Moreover, we introduce a constraint that restricts the use of 529 plan funds to college tuition, excluding all other types of expenditures. We also set non-negativity constraints on wealth, the amount invested, and the number of insurance units purchased.

Based on the results obtained from the model, we also analyze the impact on government finances. First, we estimate the number of students who are eligible for the assumed expansion to calculate how much the burden would increase if the educational support program were expanded. From data provided by the Ministry of Education, Culture, Sports, Science and Technology (MEXT), we obtained the total number of undergraduate, graduate, junior college, technical college, and vocational college students. Then, from the data provided by the Japan Student Services Organization (JASSO), we obtain the percentage of students in each household income group. Thus, the total number of students in each household income group can be calculated. Furthermore, since the data from the MEXT provides the percentage of students attending national,

public, and private schools, the total number of students by annual household income can be further disaggregated by school type. Additionally, data from the JASSO can be used to determine the percentage of students by type of residence. This shows that it is possible to distinguish between students who commute from home and those who live away from home. In this way, the number of students who are eligible for the assumed expansion can be obtained. In contrast, the loss in tax revenue from the introduction of 529 plans is estimated by calculating the annual tax that would have been collected if a 20.315% tax rate had been applied to investment gains within the 529 plans. This tax rate corresponds to the standard income tax rate applied to investment income in Japan. By comparing these fiscal burdens, we can estimate the effect on the government side of introducing 529 plans.

3. RESULTS

We assume the annual household income to be 3.5 million yen, the plan period to be 22 years, the age of the householder at time 0 to be 30 years old, and the confidence level of CVaR to be 80%. We conduct numerical analysis for some cases. The results show that the expected terminal wealth is 23.29 million yen, and the CVaR is 16.12 million yen in the case of preparing for college tuition with educational insurance. In contrast, the expected terminal wealth is 23.9 million yen, with a CVaR of 16.31 million yen in the case of the 529 plan. Therefore, the 529 plan is superior to the educational insurance in both return and risk measures, and the educational insurance is considered less financially beneficial and not attractive. This is because the primary benefit of educational insurance is the waiver of premiums in the event of the policyholder's death, but the probability of the householder's death before the child becomes a college student is only about 1.9%.

To analyze the effectiveness of introducing 529 plans on the government, we compare the fiscal burden of the educational support program with that of 529 plans. We assume that the Japanese government increases the support for students whose households have an income between 2.2 million and 6.4 million yen in the study support program. Specifically, we suppose the amount of expense supported by the government for households whose incomes are below 2.2 million yen to be N. Under the current system, the benefit ratios are $2N/3$ for households earning between 2.2 and 3 million yen, $N/3$ for those between 3 and 3.8 million yen, and $N/4$ for those between 3.8 and 6.4 million yen. In the expanded scenario where the benefit ratios rise to N, $2N/3$, and $N/3$ for the corresponding income brackets, respectively, an increase of 193.3 billion yen is expected due to the rise in the benefit ratio. Additionally, under the assumption of a 10% increase in the benefit amount for currently eligible individuals, we obtain the result that the increase in benefit amounts would lead to an additional expenditure of 76 billion yen. On the other hand, the estimated annual decrease in tax revenue due to the introduction of 529 plans is 54.2 billion yen. In a sensitivity analysis, the tuition increase rate shows that 529 plans can mitigate the decline in the CVaR compared to educational insurance. In Japan, where tuition fees are increasing, households can better manage these rising costs by utilizing a 529 plan. Consequently, the introduction of 529 plans has the potential to reduce the budget for the educational support program and reduce the long-term fiscal burden on the government.

4. CONCLUSION

In this study, we analyzed the effect of introducing 529 plans in Japan by modifying the multi-period stochastic programming model suggested by Hibiki (2011). Our results indicate that 529 plans are likely to outperform educational insurance in terms of both expected terminal wealth and CVaR measures. Specifically, given the current inflationary environment, investing solely in risk-free assets carries considerable risk, and it is essential to recognize the importance of incorporating risky assets into investment strategies. We also evaluate the fiscal impact on the government. Should current inflation persist, the educational support program needs to be projected to expand. The introduction of 529 plans enhances households' ability to cope with inflation, potentially mitigating the expansion of the educational support system and consequently reducing the government's fiscal burden. Future research should focus on developing more realistic models and exploring the optimal combination of 529 plans and educational insurance.