



Pension Choices of Senior Citizens in Thailand: A Multi-Label Classification with Generalized Maximum Entropy

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Abstract : Following the World Bank's five pillars conceptual framework, this study applied the Classifier Chain Generalized Maximum Entropy (CC-GME) method to examine individual characteristics of senior citizens with different choices of pension options in Thailand. The CC-GME model was developed for the multi-label classification problem, which can directly be applied to estimate a discrete choice model where each individual has more than one pension plan. As the model is GME based, it benefits from the semi-parametric nature of the model and can predict a set of pension plans chosen by each senior citizen without making an assumption on the error distribution. Moreover, GME is robust to the multicollinearity problem allowing us to study correlated pension choice determinants. The results show that the majority of Thai senior citizens rely more on their saving, family and government universal supports as only a small percentage have social security benefits or workplace pensions. The lack of financial stability problem is especially serious among people without high school degree and live in the rural area.

Keywords : pension; aging society; generalized maximum entropy; classifier chains.

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1 Introduction

Thailand is currently facing a rapid increase in the aging of its population. Vulnerability to poverty after retirement has become a challenge for every sector of society, and particularly for Thai elders who have inadequate savings and those who rely on the government program, the Old-Age Allowance, as their primary source of income. The research of [1] reveals that most elderly Thais are facing a risk of poverty after their retirements and tend to lack consumption smoothing in old age, as most low-income elderly are still saving insufficient amounts or not saving at all, especially members of rural Thai households. Additionally, [1] also detailed that the foremost source of financial support is changing from government support to family support, as the Old-Age Allowance program only pays THB 1,000 or lower per individual each month depending on the age of the recipients. The government is attempting to raise the number of Thai workers participating in the Thai social safety net program and the number of participants in both the social security program and the government pension fund. From 1995-2000, membership increased by more than 30 percent. Still, the number of elderly who rely on family support as their main source of income is still high. The program does not cover the entirety of the labor force, and there is a large number of workers who do not get paid, as well as an increasing old-age dependency ratio, which implies that the current labor force must work harder not only for themselves, but also for their older dependents.

[2] suggests financial security programs for the elderly to protect against the risk of poverty in old age, and to smooth consumption from work to retirement, with the components of strengthening social insurance and the implementation of contractual savings systems. However, there are significant differences among various countries. Thus, this policy framework is flexible depending on each country's conditions, such as demographic profile, macroeconomic environment, institutional capacity, and financial market status. Nevertheless, the initial conditions suggest that they should include mandatory and voluntary pension systems, social security schemes, family supports, and community supports. The World Bank then developed the Five Pillar Pension System for achieving these objectives. [3] reveals that the five pillars in the case of Thailand are as follows:

Zero pillar is a social pension covering all of the elderly in society universally with non-contributory social assistance financed by the government. In the case of Thailand, we have the Old-Age Allowance program, which is a non-contributory social protection scheme aiming to guarantee basic monthly income of THB 600 - 1,000 for all Thai senior citizens aged 60 and above with no government provided pensions.

First pillar is a public pension plan with mandatory contributions linked to earnings and with the objective of replacing some portion of lifetime pre-retirement income. In the case of Thailand, the examples are workplace pensions in which the government or employer provides pension and social security in the case of old-age benefits that could be payable on a monthly basis or as old age gratuity payable in a lump sum amount.

Second pillar is a personal pension plan, and mandatory defined contribution plan with independent investment management. In the case of Thailand, an example is the Government Pension Fund (GPF).

Third pillar includes personal and voluntary pension plans taking many forms, such as individual savings ; employer sponsored; defined benefit or defined contribution. In the case of Thailand, examples are Provident Fund (PVD) and Retirement Mutual Fund (RMF).

Fourth pillar is informal support (such as family includes support from partners, children, parents or cousin), and private savings (includes savings in cash, valuable assets such as stocks, bonds, land, diamonds, and savings insurance).

There exists heterogeneity in retirement plans that Thai senior citizens currently have. Identifying characteristics of senior citizens with and without each pillar of pension can help policy makers to visualize the broad picture of Thailand's current pension situation. There are some characteristics within each class of retirement plan that depend on the age of the recipients, such as the Old-Age Allowance program that only pays THB 600 - 1,000 each month depending on the age of recipients. [4] found that there is variation in the retirement behavior of men and women with respect to their own, or their spouses' income flows. [5] found that low levels of education and financial literacy are two of the determinants of inadequate saving. [6] also find that greater knowledge is associated with higher financial saving. [7] reports that women are more risk-averse than men, as demonstrated by the difference in their choices of pension plan. By using 2009 data from the National Statistical Office, [8] found that rural Thai households tend to face issues regarding saving inadequacy more frequently than urban households. [9] demonstrated that having more children increases the likelihood of receiving support from children and decreases the chance of receiving support from others. Thus, this study encourages the use of the World Bank's five pillars conceptual framework to address the needs of Thailand's elderly population.

This study examines the distribution of Thai senior citizens' choices of pension options classified according to the World Bank's pension conceptual framework. Moreover, this study also examines the individual characteristics of senior citizens with different choices of pension options in Thailand using [10]'s Classifier Chain Generalized Maximum Entropy (CC-GME) model. We utilize this model in our study because the Classifier Chain (CC) model was developed to study the multi-label classification problem where individuals may choose more than one choice from the choice set. As the Generalize Maximum Entropy (GME) method is semi-parametric, the GME method has an advantage over the traditional logit and probit based choice models as the logit and probit based models are parametric and have limitations when the data do not have logistic or normal distribution. Additionally, GME models yield estimated parameters with the smallest possible variances. Thus, the models robustly estimate all relevant parameters and capture the dependence pattern among alternatives.

1.1 Data Description

The data used in this table are from the 2014 Survey of Older Persons (2014 SOP) in Thailand, collected by Thailand's National Statistical Office. This survey has 38,695 Thai senior citizens aged 60 years or over in all regions in Thailand.

As mentioned in the introduction, [2] categorizes pension plans into five pillars. With the restriction of the data, this study was unable to perfectly classify all senior citizens' retirement plans into the five pillar pensions. The 2014 SOP provides the information on the pensions under World Bank's pillar 0, 3 and 4. However, the 2014 SOP excludes information on the government pension fund (GPF) and, thus, we cannot separately observe the World Bank's pillar 1 and 2. The data, however; allow us to separately observe the pensions provided by the Social Security Program and their workplace. This study then classifies the Social Security and workplace pensions in two separate classes. Moreover, the 2014 SOP only provides information on individual savings without specifying the types. Therefore, we cannot observe Provident Fund (PVD) and Retirement Mutual Fund (RMF) and, thus, and we also cannot separately observe World Bank's pillar 3 and 4. Therefore, we group all types of individual saving into one class.

To follow the World Bank's framework under the data restriction, we classified Thai senior citizens's retirement plans into five classes including (1) the Old Age Allowance Program in pillar 0 as pension class 0; (2) Social Security in the case of old-age benefits in pillar 1 as pension class 1; (3) workplace pension in pillar 1 and 2 as pension class 2; (4) private savings in the form of cash savings and valuable assets such as stocks, bonds, land, gold, and savings insurance in pillar 3 and 4 as pension class 3; and (5) family support in pillar 4 as pension class 4 including support from partners children, parents or their cousin. The variable descriptions and data statistics are shown in Table 1.

Table 1: Data description

| Variables | Description | Mean | Std. Dev. |
|------------------|--|--------|-----------|
| x_{age} | Age | 69.861 | 7.934 |
| $x_{married}$ | Dummy (= 1 if married) | 0.629 | 0.483 |
| x_{edu_hs} | Dummy (= 1 if high school or higher) | 0.100 | 0.411 |
| x_{edu_c} | Dummy (= 1 if college or higher) | 0.056 | 0.363 |
| x_{male} | Dummy (= 1 if male) | 0.442 | 0.496 |
| x_{urban} | Dummy (= 1 if urban) | 0.544 | 0.498 |
| x_{ch_male} | Number of male children | 1.604 | 1.329 |
| x_{ch_female} | Number of female children | 1.632 | 1.367 |
| x_{ch_total} | Number of total children | 0.745 | 0.780 |
| y_2 (class 2) | Dummy (= 1 if elderly choose pension class 2) | 0.030 | 0.168 |
| y_1 (class 1) | Dummy (= 1 if elderly choose pension class 1) | 0.007 | 0.082 |
| y_3 (class 3) | Dummy (= 1 if elderly choose pension class 3) | 0.790 | 0.408 |
| y_0 (class 0) | Dummy (= 1 if elderly choose pension class 0) | 0.790 | 0.349 |
| y_4 (class 4) | Dummy (= 1 if elderly choose pension class 4) | 0.866 | 0.301 |

2 Methodology

To examine the individual characteristics of senior citizens with different choices for pension options in Thailand by adapting Classifier Chain Generalized Maximum Entropy (CC-GME) model to pension choices of Thai senior citizens. The model can be written as follows.

$$y_2 = f(x_{age}, x_{married}, x_{edu_hs}, x_{edu_c}, x_{male}, x_{urban}, x_{ch_male}, x_{ch_female}, x_{ch_total}) \quad (1)$$

$$y_1 = f(x_{age}, x_{married}, x_{edu_hs}, x_{edu_c}, x_{male}, x_{urban}, x_{ch_male}, x_{ch_female}, x_{ch_total}, y_2) \quad (2)$$

$$y_3 = f(x_{age}, x_{married}, x_{edu_hs}, x_{edu_c}, x_{male}, x_{urban}, x_{ch_male}, x_{ch_female}, x_{ch_total}, y_1, y_2) \quad (3)$$

$$y_0 = f(x_{age}, x_{married}, x_{edu_hs}, x_{edu_c}, x_{male}, x_{urban}, x_{ch_male}, x_{ch_female}, x_{ch_total}, y_3, y_1, y_2) \quad (4)$$

$$y_4 = f(x_{age}, x_{married}, x_{edu_hs}, x_{edu_c}, x_{male}, x_{urban}, x_{ch_male}, x_{ch_female}, x_{ch_total}, y_0, y_3, y_1, y_2) \quad (5)$$

2.1 Model Specification

Let the Ω be a choice set with M alternatives and y_{ij} be a dummy variable where $y_{ij} = 1$ when individual i chooses alternative j . For the multi-label model, each senior citizen may choose more than one alternative. That is we can have the case where $y_{ij} = 1$ for more than one j . Thereby, there are 2^M possible outcomes. The CC model allows for correlation among alternatives or correlation among pension choices. For the objective of multi-label, we use the CC method to decompose $Pr\{y_i = A|x_{ik}\}$, where y_i is the set of all alternatives that individual i chooses and $A \in 2^\Omega$. We then can expand $Pr\{y_i|x_{ik}\}$ using the Chain Rule of Probability as follows

$$Pr\{y_i|x_{ik}\} = Pr\{y_{i1} = 1|x_{ik}\}Pr\{y_{i2} = 1|y_{i1}, x_{ik}\} \dots Pr\{y_{iM} = 1|y_{i1}, y_{i2}, \dots, y_{i(M-1)}, x_{ik}\}, \quad (6a)$$

or

$$Pr\{y_i|x_{ik}\} = \prod_{j=1}^M Pr\{y_{ij} = 1|\tilde{x}_{ij}\} = \prod_{j=1}^M G(\tilde{x}_{ij}\beta_j), \quad (6b)$$

where $\tilde{x}_{i1} = (x_{i1}, x_{i2}, \dots, x_{iK})$ and $\tilde{x}_{ij} = (y_{i1}, \dots, y_{ij}, x_{i1}, \dots, x_{ik}, \forall j = 2, \dots, M)$. The CC method then reduces the multi-label choice program to M single label choice problems $Pr\{y_{ij}|\tilde{x}_{ij}\}$ for all $j = 1, \dots, M$, which can be estimated using the GME method.

Let $y_{ij} = \tilde{p}_{ij} + e_{ij} = G(\tilde{x}_{ij}\beta_j) + e_{ij}$ where $e_{ij} = \sum_h V_h w_{ijh}$. Let k_j be the index for elements in \tilde{x}_{ij} . To simultaneously estimate \tilde{p}_{ij} and w_{ijh} for all j , the GME model is to maximize the entropy function as

$$\max_{\tilde{p}, w} H(\tilde{p}_{ij}, w_{ijh}) = - \sum_{ij} \tilde{p}_{ij} \log(\tilde{p}_{ij}) - \sum_{ijh} w_{ijh} \log(w_{ijh}) \tag{7}$$

Subject to

$$\sum_i \tilde{x}_{ijk_j} y_{ij} = \sum_i \tilde{x}_{ijk_j} \tilde{p}_{ij} + \sum_{ih} \tilde{x}_{ijk_j} v_h w_{ijh}, \quad \forall j = 1, \dots, M, \tag{8}$$

$$\forall k_j = 1, \dots, (K + j - 1)$$

$$\sum_h w_{ijh} = 1, \quad \forall i = 1, \dots, N, \forall j = 1, \dots, M, \tag{9}$$

where equation (7) is the entropy function, and (8) are stochastic-moment constraints and (9) are normalization constraints, respectively. To solve this maximization problem, the Lagrange function can be expressed as

$$\begin{aligned} L(\tilde{p}_{ij}, w_{ijh}) = & - \sum_{ij} \tilde{p}_{ij} \log(\tilde{p}_{ij}) - \sum_{ijh} w_{ijh} \log(w_{ijh}) \\ & + \sum_{jk} \lambda_{jk} \left[\sum_i \tilde{x}_{ijk_j} y_{ij} - \sum_i \tilde{x}_{ijk_j} \tilde{p}_{ij} - \sum_{ih} \tilde{x}_{ijk_j} v_h w_{ijh} \right] \\ & + \sum_{ij} \delta_{ij} [1 - w_{ijh}] \end{aligned} \tag{10}$$

The solution to this Lagrangian problem are

$$\hat{p}_{ij} = \exp \left(-1 - \sum_k \lambda_{jk} \tilde{x}_{ijk_j} \right) \tag{11a}$$

and

$$\hat{w}_{ijh} = \frac{\exp(-\sum_k \hat{\lambda}_{jk} \tilde{x}_{ijk_j} v_h)}{\sum_h \exp(-\sum_k \hat{\lambda}_{jk} \tilde{x}_{ijk_j} v_h)} \tag{11b}$$

As shown in [11], the Lagrange multipliers λ_{jk} are equivalent to the slope parameters $-\beta_{jk}$ in the traditional logit model and can represent the relationship between each \tilde{x}_{ijk_j} and y_{ij} .

To interpret the result, we use the marginal effects to measure how a small change in each individual characteristic affects the probability. The effect of a change in x_k on the probability of choosing an alternative $j \in \Omega$ or the marginal effect is

$$\frac{\partial Pr\{y_j|\tilde{x}_j\}}{\partial x_k} = \beta_{jk} G'(\tilde{x}_j \beta_j). \tag{12}$$

Moreover, the CC-GME model can also capture the dependence among alternatives that an individual faces. The dependence between an alternative j and another alternative q , where $q < j$, can be captured from the marginal effects of the change in y_q on $Pr\{y_j|\tilde{x}_j\}$, which is

$$\frac{\partial Pr\{y_j|\tilde{x}_j\}}{\partial y_q} = \beta_{j(K+q)}G'(\tilde{x}_j\beta_j). \quad (14)$$

3 Results

Table 2 illustrates the distribution of Thai senior citizens' choices between various pension options. Specifically, the table shows the percentage of senior citizens that at least have the given set of pension plans. The results tell us that most elderly individuals receive income from the Old-Age Allowance Program and their family support with the percentages of 85.78 and 86.61, respectively. Only 0.68 and 2.91 percent receive income from social security and workplace pensions. However, 78.96 percent of the elderly have their own individual savings. This reflects that only a small portion of Thai senior citizens chose a job with social security benefits or workplace pensions and the majority rely on their saving, family and government supports.

Table 2: The distribution of Thai senior citizens' choices of pension classes

| Pension classes | N | Percentage | Pension classes | N | Percentage |
|---------------------|-------|------------|-------------------------------|-------|------------|
| $\{y_0\}$ | 33192 | 85.78 | $\{y_0, y_1, y_3\}$ | 147 | 0.38 |
| $\{y_1\}$ | 265 | 0.68 | $\{y_0, y_1, y_4\}$ | 133 | 0.34 |
| $\{y_2\}$ | 1127 | 2.91 | $\{y_0, y_2, y_3\}$ | 553 | 1.43 |
| $\{y_3\}$ | 30552 | 78.96 | $\{y_0, y_2, y_4\}$ | 594 | 1.54 |
| $\{y_4\}$ | 33512 | 86.61 | $\{y_0, y_3, y_4\}$ | 22892 | 59.16 |
| $\{y_0, y_1\}$ | 172 | 0.44 | $\{y_1, y_2, y_3\}$ | 10 | 0.03 |
| $\{y_0, y_2\}$ | 652 | 1.68 | $\{y_1, y_2, y_4\}$ | 9 | 0.02 |
| $\{y_0, y_3\}$ | 25802 | 66.68 | $\{y_1, y_3, y_4\}$ | 168 | 0.43 |
| $\{y_0, y_4\}$ | 29337 | 75.82 | $\{y_2, y_3, y_4\}$ | 843 | 2.18 |
| $\{y_1, y_2\}$ | 11 | 0.03 | $\{y_0, y_1, y_2, y_3\}$ | 6 | 0.02 |
| $\{y_1, y_3\}$ | 224 | 0.58 | $\{y_0, y_2, y_3, y_4\}$ | 505 | 1.31 |
| $\{y_1, y_4\}$ | 200 | 0.52 | $\{y_0, y_1, y_3, y_4\}$ | 112 | 0.29 |
| $\{y_2, y_3\}$ | 998 | 2.58 | $\{y_0, y_1, y_2, y_4\}$ | 5 | 0.01 |
| $\{y_2, y_4\}$ | 956 | 2.47 | $\{y_1, y_2, y_3, y_4\}$ | 8 | 0.02 |
| $\{y_3, y_4\}$ | 26485 | 68.45 | $\{y_0, y_1, y_2, y_3, y_4\}$ | 5 | 0.01 |
| $\{y_0, y_1, y_2\}$ | 6 | 0.02 | Total | 38695 | 100 |

The CC-GME results of this study provide us with multi-label classification of choices of financial retirement plans. Specifically, the model allows us to examine the dependence among financial retirement plans that a senior citizen has at the time of survey. Moreover, the model also illustrates average characteristics of senior citizens within each class of retirement plans. It should be noted that the

study provides information on retirement classification for a more complete picture of pension and saving situation among senior citizens in Thailand and does not imply causality.

Table 3: The marginal effects for the CC-GME model

| Alternative Regressor | y_2 | y_1 | y_3 | y_0 | y_4 |
|-----------------------|-------------------|-------------------|-------------------|-------------------|-------------------|
| x_{age} | 0.001 (0.000) | 0.000 (0.000) | -0.004 (0.000) | 0.007 (0.000) | 0.002 (0.000) |
| $x_{married}$ | 0.034 (0.002) | 0.000 (0.001) | 0.021 (0.005) | 0.004 (0.004) | 0.023 (0.004) |
| $x_{edu.hs}$ | 0.084 (0.007) | 0.009 (0.003) | 0.047 (0.010) | -0.278 (0.012) | -0.030 (0.008) |
| $x_{edu.c}$ | 0.019 (0.004) | -0.001 (0.001) | 0.134 (0.010) | -0.151 (0.014) | -0.033 (0.011) |
| x_{male} | -0.042 (0.002) | 0.002 (0.001) | 0.034 (0.005) | -0.031 (0.004) | -0.064 (0.004) |
| x_{urban} | 0.017 (0.002) | 0.003 (0.001) | -0.009 (0.004) | -0.022 (0.003) | 0.007 (0.003) |
| $x_{ch.male}$ | -0.004 (0.001) | -0.001 (0.000) | -0.002 (0.002) | 0.005 (0.001) | 0.015 (0.001) |
| $x_{ch.female}$ | -0.004 (0.001) | -0.001 (0.000) | 0.002 (0.002) | 0.007 (0.001) | 0.019 (0.001) |
| $x_{ch.total}$ | 0.000 (0.001) | 0.001 (0.001) | -0.020 (0.003) | -0.008 (0.002) | -0.008 (0.002) |
| y_2 | - | -0.001 (0.002) | 0.071 (0.013) | -0.062 (0.011) | 0.022 (0.008) |
| y_1 | - | - | 0.030 (0.031) | -0.052 (0.015) | -0.022 (0.016) |
| y_3 | - | - | - | -0.021 (0.004) | 0.030 (0.004) |
| y_0 | - | - | - | - | 0.048 (0.005) |

Standard errors in parentheses.

Table 3 showed the result section is divided into two main parts (1) the dependence among the choices of retirement plans and (2) the characteristics within each class of retirement plans.

Dependence among choices of financial retirement plan

The CC-GME model allows us to see the dependence pattern among choices of retirement plans. Let us first consider the group with workplace pension, which consists mainly of government officers and other private employees with employer-provided pensions. The positive and significant correlation between workplace pension and individual saving implies that an average senior citizen with workplace pension has not only the government or employer provided pension, but also

private saving for their retirement. It should be noted that the workplace pension may be in the form of annuity or onetime cash grant after retirement. Therefore, it is also possible that the saving comes from the cash grant. The insignificant relationship between workplace pension and family support implies that this group of senior citizens do not receive financial support from their families. Since this group have both pension and saving, it is likely that they do not require no financial support from the families.

Senior citizens with social security benefit are mostly employees in the private sector. In contrast with the group with government or employer provided pension, this group does not have significance private saving for retirement or family support. For senior citizens with no government provided pension can register to receive the old age allowance. However, the negative and significant relationship between the workplace and social security pensions and old age allowance registration implies that people with some pension benefits are unlikely to register for old age allowance. This can potentially be because the old age allowance program only pays THB 1,000 or lower each month depending on the age of recipients. Therefore, some people with enough income may not be interested. Those who register for the old age allowance, on the other hand, tend to have less saving and are likely to also need financial support from their families. This should be a concern as the majority of senior citizens in Thailand fall into this group that relies on old age allowance and/or family supports.

Characteristics within each class of retirement plans

Older senior citizens are more likely to rely on workplace pension, old age allowance program and family support than the social security and saving. For education, people with college degree are more likely to rely on their own saving and not workforce pension, social security, old age allowance or family support. It is possible that they are more likely to take on a job that does not tie to pension benefits. People with high school degree, in addition to the private saving, are more likely to choose a job with workplace pension and social security benefit. Male senior citizens are more likely to choose a job with social security and less likely to choose a job with workplace pension comparing to female. Male also have more saving and rely less on the old age allowance program and family support. The results regarding the gender differences are consistent with the report, *The Changing Well-being of Thai Elderly from the 2011 Survey of Older Persons in Thailand*. People living in the urban area are more likely to have workplace pension and social security benefit. However, they tend to have less saving and have to rely more on family support. These results for the urban factor contradict the results from [1] that states that people in the rural area have less saving.

In addition to the individual factors, family factors are also important in analyzing each senior citizen's retirement plan. A married individual with at least one child, either male or female, tend to have more family support. However, as the number of children goes up, the senior citizens tend to face lower saving and family support. Since a large portion of senior citizens relies on family support, which requires that they have a few children, a reduction in the fertility rate can

have two implications. If the reduction of fertility rate is due to the reduction in the number of children per couple, then the couple is more likely to receive a better family support after retirement. However, if the reduction of fertility rate comes from people not having children at all, then the future senior population will not be able to rely as much on the family support.

4 Conclusion

The results from this study show that only a small portion of Thai senior citizens chose a job with social security benefits or workplace pensions and the majority rely on their saving, family and government supports. More specifically, senior citizens with high school degree but no college degree are most likely to have social security and workplace pensions. Individuals with college degree rely more on their savings and individuals without high school degrees rely more on the Old-Age Allowance Program and family support. Moreover, individuals living the urban and rural areas have different pattern of retirement plans. While people in the urban area are more protected from having a higher rate of social security and workforce pensions, people in the rural area have a higher rate of individual savings.

The results show the necessity and success of the Old-Age Allowance Program. However, the Old-Age Allowance Program should only be needed as the last resource. The people who are capable should be encouraged to save for their own retirements, either in the forms of individual savings or work related pensions. As the results emphasize the importance of family supports among several groups of senior citizens, the reduction in the fertility rate can cause the uncertainty in the future generations. The social security or other workplace pension will be more needed, especially for individuals with education lower than college. As all work-related pensions need to be acquired at a younger age, retirement planning must be taught before the high school level and should be emphasized in the rural area.

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