Uniwersytet Gdański | Związek Uczelni Fahrenheita
Prof. dr hab. Paweł Miłobędzki
Katedra Ekonometrii, Wydział Zarządzania, ul. Armii Krajowej 101, 81-824 Sopot
e-mail: pawel.milobedzki@ug.edu.pl

Statement on

"Optimal Investment Strategies and Risk Sharing in a Hybrid Pension Scheme"

by **Xiaohong Xie**,

submitted as her doctoral thesis to the Economics and Finance Scientific Discipline Committee of the Nicolaus Copernicus University in Toruń[1]

Given the prevailing trend of rising life expectancy and ageing populations in numerous countries, along with declining fertility rates, the effective design of pension schemes has become crucial for the well-being of current workers, future retirees, and their descendants, and the economic growth and development of the nations.[2] As such, Xiaohong Xie's thesis on a hybrid pension scheme for China and Poland, incorporating elements of defined benefit and defined contribution plans and discussing optimal investment strategies and risk sharing, is particularly pertinent. Making the design of such a scheme persuasive, in particular showing it is effective in managing demographic risks and maintaining financial sustainability,[3] is very demanding and requires combining theoretical and applied knowledge on various issues in contemporary economics and finance, that is on intemporal household choice, life cycle models and saving, retirement plans and private pensions, social security and public pensions, as well as on demographic trends, their forecasts and macroeconomic effects. Having examined the thesis I can confidently affirm that Xiaohong Xie has demonstrated sufficient competence in these areas. She outlined an original research programme in the dissertation, which she then efficiently implemented. Later in this statement, I will provide some critical comments on the text; however, I believe it serves as a good basis for applying for a doctoral degree in social sciences, specifically economics and finance.

The thesis is written in English, comprising 154 pages, an introduction, five chapters, a conclusion, references, and an appendix. It is well-organized, and the title effectively represents its content. The hypotheses regarding the projected hybrid pension scheme are complete, and the declared methodology involving overlapping generation models, Monte Carlo

[1] I made this statement at the request of Prof. Magdalena Osińska, the Head of Economics and Finance Scientific Discipline Committee at the Nicolaus Copernicus University in Toruń, dated 28 May 2024. The assessments contained therein comply with the Law on Higher Education and Science of 20 July 2018, Article 187, Par. 1–3, as published in Dziennik Ustaw 2018, Item 1668 with subsequent amendments.

[2] See Lindbeck A, Persson M (2003) The Gains from Pension Reform. Journal of Economic Literature, 41(1): 74–112; Barr N, Diamond P (2006) The economics of pensions. Oxford Review of Economic Policy, 22(1): 15–39; Hinrichs K (2021) Recent pension reforms in Europe: More challenges, new directions. An overview. Social Policy and Administration, 409–422; Costrell RM, McGee JB (2023) Toward an economic reformulation of public pension funding. Journal of Pension Economics and Finance, 1–29; Berardi A, Tebaldi C (2024) Saving for retirement in Europe: the long-term risk-return tradeoff. Journal of Pension Economics and Finance, 23: 272–293.

[3] See the aim and scope of the thesis declared in the Introduction, pp. 7–8.

simulations, and Bayesian optimisation is appropriate. Thoughtfully created illustrations and tables accompany the discussions and can be understood without referring to the text. The dissertation concludes with a relatively exhaustive and up-to-date summary of relevant literature. This summary includes 120 items in microeconomics, financial economics, public economics, labour, and demographic economics, encompassing items of fundamental importance. I am pleased to say that the PhD candidate is the co-author of one such paper.[4] The Appendix contains partial Python code for estimating the Lee-Carter model, forecasting various demographic variables, and simulating pension schemes. The dissertation has been meticulously prepared in editorial terms. I have noted only minor editorial errors in the manuscript.

Chapter One—Characteristics of Pension Schemes—provides a brief yet comprehensive overview of theoretical pension schemes and their implementation in China and Poland. The literature review on the pension schemes in both countries and the figures characterising their features such as the number of participants and financial flows are sound. However, the captions under all figures and tables referring to data sources are too general and not informative, both in the paper and electronic version of the thesis. Tables 1.1 and 1.5, which summarise the pension schemes in China and Poland, are not discussed in the text. They might be a crucial part of the conclusion for this chapter, which is now missed.

Chapter Two—Population Dynamics—is dedicated to the population dynamics analysis to propose a hybrid pension scheme for China and Poland. The literature review here is focused on mortality rate forecasting and its application in pension schemes. The Lee-Carter model and its extensions that enable geometric and hyperbolic decay are considered the most suitable choices in this context. However, using only the latter for projecting mortality rates may raise two concerns. First, its superiority over two competitors in terms of RMSFE seems to be due to the data split into training and testing periods, the latter of which includes the COVID-19 pandemic. Second, this hyperbolic decay may not exhibit mortality rate dynamics over the next hundred years. Thus I would rather use all three models for the projections. For a robustness check, I would compare these and other projections, including fertility, life expectancy, and population structure, with those provided by the United Nations, Eurostat, and Statistics Poland.[5]

Chapter Three—Hybrid Pension Scheme Potential for Risk Sharing—brings a nuanced tool that helps evaluate a hybrid pension scheme's potential for a more balanced distribution of risk among generations. Here, the PhD candidate outlines in detail an overlapping generations model that later becomes a workhorse in the search for optimal investment strategies in the collective hybrid pension plan. Using Bayesian optimisation of the lifetime utility of

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[4] See Xie X, Osińska M, Szczepaniak M (2023). Do young generations save for retirement? Ensuring financial security of Gen Z and Gen Y. Journal of Policy Modelling, 45(3), 644–668.

[5] See *World Population Prospects 2024. Summary of Results*. United Nations, Department of Economic and Social Affairs, available at World Population Prospects 2024: Summary of Results | Population Division (un.org); *Population projections in the EU*, available at https://ec.europa.eu/eurostat/statistics-explained/index.php?oldid=497115# Population_projections; *Prognoza ludności na lata 2023–2060* (Population projection 2023–2060), available at https://stat.gov.pl/ obszary-tematyczne/ludnosc/prognoza-ludnosci/prognoza-ludnosci-na-lata-2023-2060,11,1.html

newly entered participants in the pension plan instead of a grid search in 4-dimensional parameter space, including contribution rate p, risk allocation parameters α and β, and investment in risky asset weight ω, is a logical choice.

Chapter Four—Optimal Investment Strategies. China Simulation—is dedicated to optimal investment strategies simulations for China. The assumptions underlying simulations are based on conclusions from in-depth demographic and regulatory trends discussion. The simulation outcomes exhibit parameters of optimal defined benefit, defined contribution, and hybrid pension schemes, as well as consumption profiles for individuals who enter the workforce at the age of 16 in 2022 and remain within it until they retire either at 60 or 65 years old, conditional on the low, moderate and high birth rate, showing the hybrid scheme outperforms its competitors in terms of welfare (certainty consumption equivalent) and consumption profile stability in most assumed scenarios, including those of high-risk investments.

Chapter Five—Optimal Investment Strategies. Poland Simulation—is a sequel to the previous one for Poland yet provides valuable comparative insights between the two countries of interest. The assumptions for simulating investment strategies consider the specific characteristics of Poland. These include the varying ages at which individuals enter the workforce and retire, and the maximum allowable percentage of high-risk assets in the pension fund portfolio. The settings are for 18, 65, and 67 years of age, and 80%, respectively. The employer's total contribution to the Employee Capital Plan is 4%. Other simulation parameters mirror those for China. The primary simulation finding is threefold. First, pension schemes are sensitive to underlying demographic trends. Specifically, higher birth rates improve welfare across all schemes. Second, the hybrid scheme performs remarkably well under a high-risk investment strategy across various birth rate conditions. Third, raising the retirement age from 65 to 67 is essential for improving welfare. More interestingly, a short comparison of the simulation outcomes for China and Poland follows in the conclusion underscoring the strengths and weaknesses of existing pension schemes in both countries and their prospects. The resulting few recommendations for social and economic policymakers end the chapter.

To sum up, Xiaohong Xie's doctoral thesis discusses the critical and intricate research problem of creating an efficient pension scheme resilient to increasing life expectancy and an ageing population which numerous countries nowadays face to resolve.[6] In the theoretical chapters, One through Three, the PhD candidate demonstrates she is familiar with the recent literature on retirement plans and social security resulting in private and public-funded pensions. This specifically pertains to those currently implemented in China and Poland. She also showed an excellent ability to model and forecast demographic trends. She added value to the field in applied chapters, Four and Five, in a series of well-established simulations finding out that a hybrid pension scheme incorporating elements of defined benefit and defined contribution plans maximises the lifetime utility of newly entered participants into the

[6] See Ageing Europe: Looking at the lives of older people in Europe. Luxembourg: Publications Office of the European Union. 2020 Edition.

pension plans in China and Poland across the reasonable and likely set of demographic and financial market scenarios. That is why I am very pleased to state she fully achieved the research goal declared in the Introduction and justified the claims comprising Hypotheses 1 to 3. Her thesis meets all the requirements of the Law on Higher Education and Science. I, therefore, recommend accepting it as it is and allowing Xiaohong Xie to defend it publicly. Has the dissertation level been substantive and are the simulation results solid, unique, and important for today's and future decision-makers, please consider distinguishing her work.

Sopot, 17th of July 2024