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**REVIEW
OF
DOCTORAL DISSERTATION**

**ENTITLED
OPTIMAL INVESTMENT STRATEGIES AND RISK SHARING IN A
HYBRID PENSION SCHEME**

**PREPARED AT
INTERDISCIPLINARY PHD SCHOOL ACADEMIA RERUM SOCIALIUM
NICOLAUS COPERNICUS UNIVERSITY IN TORUN
BY XIAOHONG XIE, M.A.**

**UNDER THE SUPERVISION OF
PROF. DR. HAB. MAGDALENA OSIŃSKA**

The review of this doctoral dissertation is prepared at the request of Prof. Magdalena Osińska, the Head of the Scientific Discipline of Economics and Finance Council at Nicolaus Copernicus University in Torun, dated May 28, 2024. The dissertation was written by Xiaohong Xie, M.A. under the supervision of Prof. Magdalena Osińska in the discipline of Economics and Finance. The thesis contains 154 pages total including the title page and the appendix. The assessments comply with the requirements defined by the Act Law on Higher Education and Science of 20 July 2018, Article 187, Par. 1–3, published in Dziennik Ustaw 2018, Item 1668 with subsequent amendments. It includes the following:

1. The doctoral dissertation presents the candidate's general theoretical knowledge in a discipline or disciplines and the ability to conduct scientific or artistic work independently.

(2) The subject of a doctoral dissertation shall be an original solution to a scientific problem, an original solution to the application of the results of own scientific research in the economic or social sphere, or an original artistic achievement.



(3) A doctoral dissertation may be a written work, including a scientific monograph, a collection of published and thematically related scientific articles, a design, construction, technological, implementation, or artistic work, as well as an independent and isolated part of a collective work.

The review consists of the following parts: selecting the topic of the work and defining the research problem; substantive and formal assessment of the work against the background of its layout; assessment of sources used in the work and conclusions.

1. Selecting the topic of the work and defining the research problem.

Pension schemes are assessed differently in different countries. Even the member countries of the European Union vary in this scheme. Globally the pension scheme has many challenges and criticism. I have sometimes considered the burden on the economy. Countries have their own pros and cons to flip schemes, but the optimal solution is still under evaluation. In this series, the current dissertation has cited a very relevant research problem backed by good literature support. This dissertation addresses a critical gap in pension management: the need for systems that adeptly balance risk, ensure sustainability, and maintain intergenerational equity amid aging populations. I also believe that the Ph.D. student proposal to develop a model through the hybrid pension scheme considers the importance of invest and risk simulating the aging population of China and Poland and will have a contribution to the policy makers. Furthermore, this comparative study is further enriched by the contrasts between the two: while both countries implement DC schemes, the specifics of their pension plans—such as contribution rates, benefits, and investment strategies—differ markedly. These differences offer valuable insights into how pension systems can be tailored to meet specific national needs while addressing common challenges such as sustainability and the management of aging populations. By analyzing these two diverse systems, the dissertation aims to uncover how varied demographic trends and policy frameworks influence the design and success of pension reforms, providing lessons on managing pension schemes in diverse socio-economic contexts.

2. Substantive and formal assessment of the work against the background of its layout.

The dissertation submitted for review is a detailed analytical report of 154 pages which consists of five chapters, excluding these five chapters there is an Introduction section at the very beginning and the end followed by a conclusion, references, and an appendix. The dissertation



holds a reasonable support of literature including the basic ones justifying the chosen concept (i.e. books, reports, and articles). The mostly literature is taken from international sources in the English language, however Polish and Chinese sources are also included as required to justify the literature to Poland and China respectively. Additionally, some literature has been extracted from internet sources. An integral part of the study is the code written in Python - attached as an appendix at the end of the dissertation. The code presented is part of chapter two, which justifies the application of the Lee-Carter model.

The doctoral student presented the dissertation in an organized manner. The Introduction gives a look at the dissertation and provides the complete map of the study but is presented separately not with chapters. This chapter starts with motivation which rationalizes the importance of study.

The further section provided an elaborated view to narrow down the research problem as the requirement of a hybrid pension scheme with the twofold contribution, *Firstly, it enhances the existing concept of hybrid pension schemes, which combine the stability of Defined Benefit (DB) plans with the flexibility of Defined Contribution (DC) plans. This approach offers a refined solution to mitigate the inherent limitations of traditional pension models. Secondly, the study integrates a sophisticated population dynamics model, leveraging actual demographic data from China and Poland to calibrate the pension schemes.*

Furthermore, the section presents the aim of the study as:

- (1) *To determine the impact of birth and mortality rates on long-run consumption under the hybrid pension scheme.*
- (2) *To compare the efficiency of traditional DB and DC pension schemes with the hybrid pension scheme.*
- (3) *To compare the results obtained for China and Poland from the demographic risk perspective.*
- (4) *To check the results for robustness by changing the key parameters.*
- (5) *To provide the pension policy recommendations for China and Poland.*

The next presentation is the well-framed hypotheses to reach the above-stated aims:

H1: There is greater stability and flexibility in hybrid pension schemes, which combine features of DB and DC plans, compared to traditional pension models when confronted with demographic shifts and economic uncertainties.

H2: There is superior performance in terms of risk management and sustainability in hybrid pension schemes, particularly in contexts characterized

by varying birth rates and aging populations, compared to standalone DB and DC schemes.

H3: There are significant differences in the suitability of pension models across different national contexts, influenced by unique demographic structures and policy frameworks.

The following section makes a snapshot of the adopted methodology, which focuses on the integration of demographic analysis, financial modeling, and advanced computational techniques to address the complexities inherent in managing pension schemes. A pivotal element of our methodology involves the integration of Monte Carlo simulations with Bayesian Optimization. This section additionally includes a detailed calibration of the pension models based on actual demographic data from China and Poland. The entire computational process is implemented using Python, facilitating the intricate modeling of demographic scenarios, financial simulations, and the application of optimization algorithms.

The next segment is the snapshot of the presentation of the dissertation from the beginning till the end.

The Introduction section presented by the Ph.D. student provides a stepwise structure with clarity on the dissertation. I notice the placement of this section before chapters, which may be a style adopted under compulsion. However, I think this section should be presented as ‘Chapter 1 – Introduction’. The motivation, research problem, aims, hypotheses, methodology, and the following presentation of the chapters are clear and well-established. Assessing both the goals of the work and the research hypotheses, it should be stated that their correct formulation usually causes many problems. However, the hypotheses formulated by the PhD student can be considered correct.

The chapter 1 is presented in 6 sub-sections altogether consisting of 23 pages. This chapter introduces pension schemes, focusing on the basic framework, types, and characteristics of various pension plans, while examining the three pillars of pension schemes in China and Poland. This section includes many countries from around the world providing a literature base. The presentation of literature through the separate sections specific to China and Poland provides a clear understanding of the policy and schemes. The Ph.D. student’s presentation on China Pension Scheme Structure (Fig. 1.1), and Poland Pension Scheme Structure (Fig. 1.4) is enough to differentiate the pension schemes in the two countries. The understanding of schemes in China presented in Table 1.1 makes sense. The incorporation of the latest data in Figure 1.2, and Figure 1.3 makes the presentation more clear. The dissertation

aims to provide a hybrid pension scheme, so this chapter is an essential requirement for this dissertation. Overall, I evaluate this chapter positively.

The next chapter is Chapter 2. Population Dynamics with 22 pages, which is focused on the demographic, and their shifting trends. Further, the chapter provides an empirical view of birth rate, death rate, and life expectancy, which play a major role in the success or failure of any pension scheme. A very informative data provided “In China, life expectancy continued to rise from 70 in 2000 to 78 in 2021 (The World Bank, 2022a). Conversely, in Poland, although life expectancy increased from 74 to 78 between 2000 and 2019, the pandemic-induced mortality spike resulted in a decrease to 76 by 2021 (The World Bank, 2022b). This shift necessitates a reevaluation of pension schemes, as longer life spans impact the sustainability of pension systems.” This chapter opts to employ the Lee-Carter model and its extensions as the primary tools for mortality projection. The contribution of the assessment tool to project the birth rate, particularly through the lens of the numerical results section, highlights their significant implications for the future population structures of China and Poland. I evaluate this chapter positively.

The third chapter provides an insight into the hybrid pension scheme on 16 pages. This chapter focuses on investigating the potential of hybrid pension schemes, which strive for a more balanced distribution of risks, facilitating intergenerational risk-sharing. The dissertation explores optimal investment strategies for collective hybrid pension plans using the Overlapping Generations (OLG) Model, which encapsulates intergenerational risk-sharing mechanisms. simulates pension plan dynamics using the Monte Carlo method. The application of the Bayesian Optimization technique to pinpoint the optimal combination of parameters that maximize welfare while accounting for demographic, economic, and financial risks. The comparative result of this model with traditional Defined Benefit (DB) and Defined Contribution (DC) plans illuminates the potential of hybrid pension schemes to manage risks more effectively and promote intergenerational equity, which is particularly pertinent for countries like China and Poland grappling with an aging population and a pressing need for financial market reforms. The model presented in equation 3.1 justifies the selection of a hybrid pension scheme. Based upon the detailed discussion with equations and simulations, the chapter clarifies the importance and applicability of hybrid pension schemes. Overall, this chapter has a good insight and I evaluate this chapter positively.

The next attempt of the Ph.D. student is providing Chapter 4, which discusses Optimal Investment Strategies specific to China Simulation, incorporated in 24 pages, and serves as a bridge connecting theoretical insights to practical applications within the realm of pension



systems, particularly within the context of China by leveraging detailed simulations and robustness tests. The chapter presents the outcome simulation incorporating demographic data in the Lee-Carter method. I evaluate this chapter positively.

Chapter 5 is the presentation of similar simulations to Chapter 4 based on the demographic data of Poland. This chapter is presented in 22 pages altogether. Table 5.5 provides the outcome of the simulation of the optimal pension scheme. I evaluate this chapter positively.

The conclusion is presented on 3 pages. It provides the theoretical solution to the problem research problem framed in the Introduction.

The chapter rationally presents the hypotheses clarification, connecting the other chapters with data and simulation on the conceptual acceptability of the hypotheses.

In this process, the aims are reached, and the dissertation provides a novelty in the subject area. This section should provide a more detailed discussion.

The general remarks on the dissertation

- *The HI needs correction as a complete sentence, not a broken sentence.*
- *I raise a question on the adoption of The World Bank's three-pillar framework established in 1994 is discussed, but 1994-2024 to date developments are missing in the discussion.*
- *Another point that needs to be clarified, is why the "the Lee-Carter model" was adopted, would be better to provide some comparative superiority of this model over other models.*
- *The conclusion on page 120, should be in sub-section 5.5.2. If so, then the Discussion should be 5.5.1.*
- *The thesis must be checked for grammar and vocabulary, which need minor corrections.*

However, I evaluate this thesis positively believing that suggested corrections will be incorporated in the thesis.

In the discussion on the hybrid pension scheme and the proposed solutions, two more general questions can be raised.

1. *What is the risk of a Hybrid Pension Scheme from the perspective of the demographic collapse we observe in Poland and China?*
2. *Can the results presented in the Theses be generalized to other countries and, if so, under which conditions?*

3. Assessment of sources used in the work

The references section has 118 references altogether including journals, web pages and reports. Though the number could be increased for a Ph.D. dissertation. However, the updated references justify the selection. The journal references are 93, and all of them are in English language. The web pages (23 different sources) are used mostly as the data sources. There are only 2 reports incorporated as the reference. *In my opinion, there can be more citations and references to strengthen the concept. Though this is also acceptable.*

4. The conclusion

The doctoral dissertation submitted for the review titled “Optimal Investment Strategies and Risk Sharing in a Hybrid Pension Scheme” presents an original work selecting an important research problem. The study deserves appreciation. The dissertation displays the rigor of research and the knowledge of the Ph.D. student. The research method adopted, and its application adds value to the dissertation. The doctoral student presented a valuable study that demonstrates skills and appropriate and substantive knowledge in this area.

Particularly, the Author demonstrated good knowledge of the research methodology on the topic, which enables conducting independent research in the field of social sciences scientific discipline of economics and finance in the future. The research performed by the PhD student can be considered valuable because of the in-depth analysis through research.

Moreover, the doctoral student:

- *presented the Chinese Pension Scheme, and Poland Pension Scheme through figures.*
- *presented the Lee-Carter model with the incorporation of demographics.*
- *projected and implemented simulations of hybrid pension schemes for China and Poland.*
- *prepared the code in Python and presented it in the appendix.*
- *defined the future scope of research, which is well aligned with the developments in technology, specifically artificial intelligence (AI).*

In my opinion, the dissertation meets the requirements of Article 187 of the Act Law on Higher Education and Science of 20 July 2018, therefore I state that the reviewed work may be the basis for applying for the academic degree of Doctor of Social Sciences in the scientific



discipline of Economics and Finance. Therefore, I recommend the Council of the Scientific Discipline of Economics and Finance at Nicolaus Copernicus University in Toruń to accept M.A. Xiaohong Xie for the public defense of her doctoral dissertation.

K. Nerman