

Impact case study (REF3b)

<p>Institution: University of Portsmouth</p>
<p>Unit of Assessment: 10 Mathematical Sciences</p>
<p>Title of case study: Use of Goal Programming Models to Assist Strategic Financial Investment Decision Making.</p>
<p>1. Summary of the impact</p> <p>This statement details the impact of research undertaken by members of the Logistics and Operational Research Group (LORG) at the University of Portsmouth in the area of strategic financial investment portfolio selection. A set of goal programming models was developed, which for the first time allowed the investment fund managers to consider a wider range of objectives beyond the usual risk and return paradigm. As a result, the decision making capabilities of key investment fund managers and advisors including those working for the Kuwait Sovereign Wealth Fund were enhanced, resulting in improved decision making capabilities.</p>
<p>2. Underpinning research</p> <p>The initial underpinning research was conducted in the period 1991-2008 by academic staff in the Logistics and Operational Research Group (LORG), which has grown from the former Logistics and Management Mathematics Group, Department of Mathematics, University of Portsmouth, under the leadership of Professor Mehrdad Tamiz (Professor of Operational Research, 1991-2008). The key academic co-investigator was Professor Dylan Jones (1997-present; Principal Lecturer during the research).</p> <p>LORG members have been internationally leading in developing the theory and applications of goal programming since 1995 until the present day. Amongst the key developments have been joint work with Prof. Carlos Romero (Polytechnic University of Madrid, Spain) on the connections between and use of different goal programming variants which are used to model different underlying philosophies such as optimisation, satisficing, balance, fairness, and ordering. Prof. Romero provided the economic expertise and Profs Tamiz and Jones the mathematical and computational expertise that enabled this work. This research provided utility interpretations of the major goal programming variants and demonstrated their connectivity (R1). These goal programming variants were subsequently expanded and combined with other Operational Research and Artificial Intelligence techniques for symbiotic advantage (R2). Particularly novel was the bridging of the gap between discrete and continuous multi-criteria models with the mixed modelling concept of using a discrete method (ELECTRE) to rank alternatives generated by a continuous method (goal programming) (R5).</p> <p>One important application area that LORG members have specialised in is that of portfolio selection and dynamic re-optimisation. The initial work in the application domain concentrated on the use of a dual phase goal programming model that was novel as it used goal programming in a combined descriptive manner (phase 1) to analyse past data and in a prescriptive manner as a portfolio selection tool (phase 2). The model minimises the risk against movements in a range of economic indices such as interest rates, exchange rates, and the oil price under a number of scenarios and was applied to a selection of a portfolio of shares from the British FTSE 100 index (R3). Between 1997 and 2000 research was undertaken into incorporating transaction costs into a dynamic portfolio selection model (R4). More recent research has concentrated on the selection of portfolios comprised of mutual funds. A three-phase mixed modelling methodology used statistical analysis, goal programming, and the ELECTRE method in order to select a portfolio of Spanish mutual funds (R5). The underpinning research continued, as demonstrated by (R6) in which Egyptian mutual funds were also modelled using different goal programming variants.</p> <p>This work also considers the use of goal programming to compose a minimal portfolio of shares that</p>

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is able to accurately track a market index such as the British FTSE 100, and examines the three major variants of goal programming: weighted, lexicographic, and Chebyshev for portfolio selection, and provides guidance as to under which circumstances each should be used. Thus, an effective framework for incorporating financial decision maker and investors' goals, objectives, and priorities has been built by LORG members.

3. References to the research

The three references marked (*), R1, R5, and R6, best represent the quality of the research.

R1(*): Romero, C, Tamiz, M and Jones, DF. (1998) Goal programming, compromise programming, and reference point method formulations: linkages and utility interpretations, Journal of the Operational Research Society, 49, 986-991. DOI: [10.1057/palgrave.jors.2600611](https://doi.org/10.1057/palgrave.jors.2600611)

R2: Jones, Dylan and Tamiz, M. (2010) Practical goal programming. International Series in Operations Research and Management Science, 141 (141). Springer, New York.
ISBN 9781441957702

<http://www.springer.com/business+%26+management/operations+research/book/978-1-4419-5770-2>

R3: Tamiz, M, Hasham, R, Jones, DF, Hesni, B, Fargher, EK. (1996) A two staged model for portfolio selection, Lecture notes in Economics and Mathematical Systems, M.Tamiz(ed), Springer, 432, 286-299. DOI: [10.1007/978-3-642-87561-8_19](https://doi.org/10.1007/978-3-642-87561-8_19)

R4: Tamiz, M., Treloar, R., (2006), "Issues Concerning Block Trading and Transaction Costs", Journal of Information and Optimisation Sciences, 27, 127-144.

<http://www.tarupublications.com/journals/jios/full-text/JIOS-27-1-2006/jios130.pdf>

R5(*): Perez Gladish B, Jones DF, Tamiz M, and Bilbao Terol A (2007) An interactive three stage model for mutual fund portfolio selection, Omega, 35, 75-88.

DOI: [10.1016/j.omega.2005.04.003](https://doi.org/10.1016/j.omega.2005.04.003)

R6(*) Tamiz M, Azmi R, Jones DF (2013) On Selecting Portfolio of International Mutual Funds using Goal Programming with Extended Factors, European Journal of Operational Research, 226, 560-576. DOI: [10.1016/j.ejor.2012.11.004](https://doi.org/10.1016/j.ejor.2012.11.004)

R1, R4, R5, and R6 are papers in highly-ranked and well-respected Operational Research journals: the journal Omega is ranked 3rd highest in SJR rankings for Operations Research and Management Science and has a 2012 5-year Impact Factor of 3.474. The European Journal of Operational Research is ranked 9th in SJR and has has a 2012 5-year Impact Factor of 2.524.

Finally, the Journal of the Operational Research Society is ranked 23rd in SJR – within the SJR top quartile – has a 2012 5-year Impact Factor of 1.282, and is the premium publication of the UK OR Society.

4. Details of the impact

The impact relates to the use of goal programming models developed by LORG members to aid in investment companies' strategic financial decision making. Members of LORG were approached by an advisor to the Kuwait Investment Authority (who are responsible for the Kuwaiti Sovereign Wealth Fund) in 2008 as she had read the group's underpinning work on portfolio selection and wished to see a set of models developed that pertained to the type of multi-objective quantitative decisions she faced in the Kuwait Sovereign Wealth Fund, as well as aiding her work as a freelance investment advisor. The Kuwait Sovereign Wealth fund is the world's oldest and most well established wealth fund, although the actual amount of its investments is not made public.

A set of goal programmes for multi-objective portfolio optimisation was thus developed by LORG

members, applying the techniques developed in the underpinning research (R1-R5) in accordance with the specifications of the advisor (Dr Azmi). These models were capable of producing balanced finance portfolios for deciding the level of investment in mutual funds that included a range of goals specified by the decision including desired levels of risk, return, and maturity of the funds being invested in. They also took into account the GDP, inflation rate, and regional priorities of the country when deciding on the investments to be made. The models were trialled against a set of Egyptian mutual funds as a demonstration of their potential. The advisor worked with LORG in the period 2008-2010 in order to assist in ensuring that the models built upon the research of LORG staff accurately reflected the objectives, priorities, goals, and constraints that a real-world portfolio investment company is faced with.

The impact has occurred on two levels. The first level is through direct collaboration between University of Portsmouth staff and professionals with responsibility for portfolio management in financial companies to apply the underpinning research to their specific problem domains. Prof Tamiz has had direct contact with portfolio managers in investment companies and institutions, having previously worked for the Nomura investment bank in London in the 1990's. Dr Azmi has been working as an economic advisor to the sovereign wealth fund of Kuwait (source 1) in the period 2008-2013. She also has a range of business contacts due to her supplemental position as a freelance trainer and consultant. In these capacities she has advised and had various formal and informal meetings with fund managers who acknowledged the use of a quantitative model in their investment decision making, in a similar vein to the goal programming models developed by LORG members in R1-R5 (Due to the nature of the investment banking industry, fund managers are not prepared to publicly state the nature of quantitative models they use or the results that these models yield). LORG members have also been active in presenting seminars and promoting the results of the models in a range of forums frequented by investment fund managers in order to enhance the use of the goal programming models developed by LORG members in the financial investment sector (Source 1). In addition, our results have guided financial decision making and investment advice given to the Kuwait Sovereign Wealth Fund and other investment funds by the knowledge of the quantitative skills and dynamics of the working of the goal programming models gained during the liaison with LORG members (Source 1). Dr Azmi has also been instrumental in promoting the concepts of achieving fairness by the use of goal programming, as detailed in references R1 and R2, to the issue of developmental planning at the United Nations, proposing goal programming models be used to achieve better levels of gender equality worldwide (Source 1).

The second source of impact is through dissemination of the results of applying the research to specific domains in scientific conferences, academic journals, and industry related publications. The work has been placed in sources S2-S3; the specialised Arab Journal of Academic Sciences (Source 2); and the Banking and Financial Systems eJournal (source 3) in order to achieve good dissemination amongst the academic and practitioner communities in the field. The results of the research have been presented at the Multi-Attribute Portfolio Selection (Montreal, 2007 – containing around 80% investment bankers and 20% academics) and MOPGP08 (Portsmouth, 2008), and MOPGP10 (Tunisia, 2010) conferences.

The research has been cited in case studies relating to the Iranian stock market (source S4) and the Chinese stock market (source S5), the Kuwait stock exchange (source S6) and in Spain relating to socially responsible investment (source S7).

5. Sources to corroborate the impact

- 1) Factual Statement from Advisor, Strategy & Planning Department, Kuwait Investment Authority.
- 2) Article in Sovereign Wealth Quarterly. January 2011, Pages 20-23.
- 3) Azmi RA: Accepting the challenges of the ongoing financial crisis and global market integration: highlighting the role of cooperative finance for sustainability, Banking and Financial Institutions eJournal, <http://ssrn.com/abstract=1583273>

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- 4) Amiri, Maghsoud; Ekhtiari, Mostafa; Yazdani, Mehdi. (2011) Nadir compromise programming: A model for optimization of multi-objective portfolio problem, Expert Systems With Applications, 38, 7222-7226. DOI: <http://dx.doi.org/10.1016/j.eswa.2010.12.061>
- 5) Li, Jun; Xu, Jiuping (2009) A novel portfolio selection model in a hybrid uncertain environment, Omega-International Journal Of Management Science, 37, 439-449. DOI: <http://dx.doi.org/10.1016/j.omega.2007.06.002>
- 6) Al-Qaheri H and Hasan MK (2010) An End-User Decision Support System for Portfolio Selection: A Goal Programming Approach with an Application to Kuwait Stock Exchange (KSE), International Journal of Computer Information Systems and Industrial Management Applications, 2.
- 7) Ballester E, Bravo M, Perez-Gladish B, Arenas-Parra M, Pla-Santamaria D (2012) Socially Responsible Investment: A multi-criteria approach to portfolio selection combining ethical and financial objectives, European Journal of Operational Research, 216, 487–494. DOI: <http://dx.doi.org/10.1016/j.ejor.2011.07.011>