

# Mix it up

**PORTFOLIO OPTIMISATION USING INSURANCE MARKET DATA**  
**Lloyd's of London / Brunel University**

## The need

Lloyd's of London is one of the world's best known insurance brands. It is not a company; it's a market where our members join together as syndicates to insure risks. There are over 75 Syndicates who offer tailored solutions to respond to the specific risks of the client base. The syndicates operating within the market cover many classes of business including marine, aviation, catastrophe and many others.

The focus of the Internship project was to develop models that would help determine the mix of business in their portfolios to provide the highest return or minimum risk. Lloyd's wished to take existing work further and refine it more extensively, using bespoke business constraints within the optimisation process.

## The outcomes

The main purpose of the project was two-fold. The first was to determine the optimal mix of classes of business at the Lloyd's level, i.e. the optimal mix with respect to the risk or return to Lloyd's of London. The second was to determine the optimal mix of classes of business at the Syndicate level.

A key result of the project was the application of advanced mathematical techniques and methodologies within the business arena and a promotion of such advanced thinking and mathematical modelling, which can now be passed on to all of the Lloyd's Syndicates. The outcomes of the project will further

go on to promote and help enhance the application of these mathematical techniques within the insurance industry.

The tools developed during the project will be used to advise both individual Syndicates and Lloyd's of London themselves on how to manage the balance between risk and return.

The intern has now subsequently been offered a role within the team at Lloyd's of London to continue this work going into the future and assist on other important modelling projects.

*"[The programme] really helped us to make significant progress ... making full use of her supervisor at Brunel. Recently, [Nilgun] presented her main findings to the Head of the Franchise Performance Directorate, who was very impressed."*

**Michael Samuels**  
**Lloyd's of London**

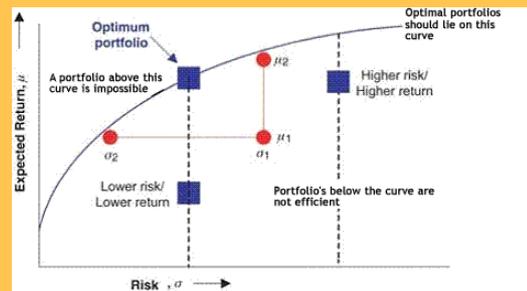
## Technical summary

The project used variance as a risk measure and proposed two mean–variance models in order to determine the optimal mix of classes of business. An optimal mix portfolio is defined as a portfolio that achieves:

- minimum level of risk (variance of underwriting profit) at a given level of underwriting profit (mean) or
- maximum level of underwriting profit (mean) at a given level of risk (variance of underwriting profit)

and by plotting the optimal portfolios, an Efficient Frontier is constructed. The figure to the right is an example of an Efficient Frontier.

All the portfolios on the frontier are optimal. The portfolio at  $(\mu_1, \sigma_1)$  is not optimal; because at the same level of return  $(\mu_1)$ , a lower level of risk  $(\sigma_2)$  can be achieved and at the same level of risk  $(\sigma_1)$ , a higher level of return  $(\mu_2)$  can be achieved.



The two models created differ in terms of the approach followed. In the first model, Lloyd's and the Syndicates were considered individually whereas in the second model, Lloyd's and the Syndicates were considered together.

The data used was insurance data in different business lines in the period 1993–2007. Premiums and paid claims were used to calculate the ultimate loss ratios and the underwriting profits for each year of account.

The models were implemented in AMPL (A Mathematical Programming Language) and solved using the FortMP solver.



This project was part of the programme of industrial mathematics internships managed by the Knowledge Transfer Network (KTN) for Industrial Mathematics. The KTN works to exploit mathematics as an engine for innovation. It is supported by the Technology Strategy Board, in its role as the UK's national innovation agency, and the Engineering and Physical Sciences Research Council, in its role as the main UK government agency for funding research and training in engineering and the physical sciences.



## Project Details

### Partners

Lloyd's of London  
Brunel University

### Project investment

£11,000

### Intern

Nilgun Canakgoz

For further details  
on the technology:

**Michael Samuels**

Lloyd's of London

[michael.samuels@lloyds.com](mailto:michael.samuels@lloyds.com)

For further information  
on internships and  
other collaborations:

**Lorcán Mac Manus**

Industrial Mathematics KTN

[lomm@industrialmaths.net](mailto:lomm@industrialmaths.net)

+44 (0) 1483 579108