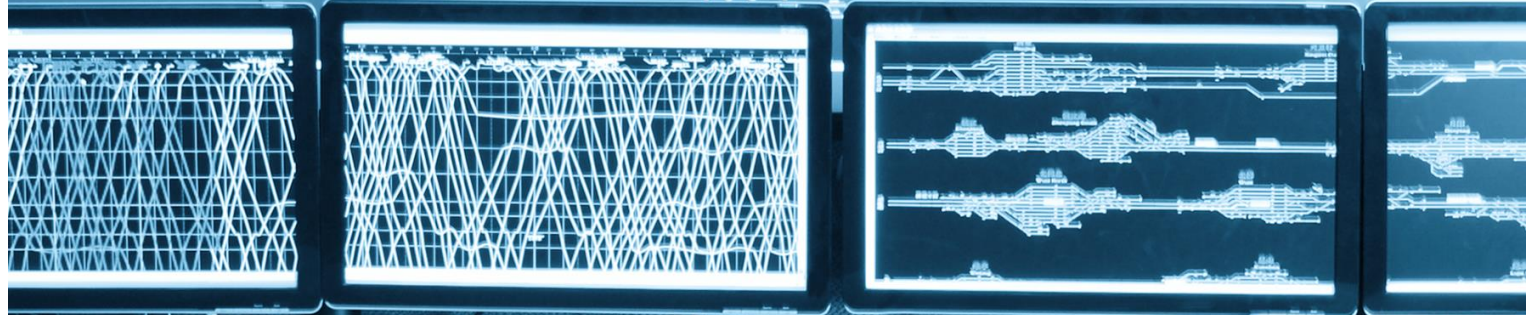# Deloitte.

XSG

Economic Scenario Generator

Risk-neutral and real-world Monte
Carlo modelling solutions for insurers

Introduction to XSG

What is XSG?

XSG is Deloitte's economic scenario generation software solution, designed to meet both the present and evolving Monte Carlo scenario modelling needs of insurance companies and other financial institutions. XSG provides users with access to libraries of financial and statistical models to support both risk-neutral and real-world stochastic modelling in a single integrated solution. The flexible nature of the software means that it can be seamlessly incorporated into your existing processes and configured to meet bespoke modelling requirements.

What can XSG be used for?

XSG can be used in the following stochastic modelling tasks:

- Market-consistent valuation and hedging of insurance liabilities

- Optimisation of investment strategy

- Risk and capital quantification

How can you use XSG?

We offer our customers a range of options for obtaining scenario files from XSG:

A. **Annual software licence:** Full access to all of the relevant XSG models and tools, allowing you to fully own the scenario generation process. The licence includes access to all the tools that we use ourselves for calibrations and generating validation reports.

B. **Licence calibrations:** You receive "base" calibration assumptions from us. Doing so provides you with a reliable base set of assumptions that can be used to create sensitivity files with the XSG software, reducing your workload and assumption-setting requirements. You can purchase base files at a frequency of your choosing.

C. **Scenarios only:** Deloitte calibrates models and generates scenario files to satisfy your requirements. We then deliver these scenario files and accompanying reports to you. This may be a useful option for companies who only require a small number of scenario files, or do not wish to take the scenario generation process in-house.

How can you find out more?

The following pages of this document summarise the models and tools of XSG, and some of our credentials. To arrange a demonstration or find out additional information about XSG, please get in touch with your usual Deloitte representative or email us at **UKDeloitteXSG@deloitte.co.uk**.

Our goal is to provide you with a technologically and methodologically advanced solution for meeting your evolving ESG requirements.

Differentiating features of XSG

The following features distinguish XSG as an ESG modelling solution:

Innovation

At Deloitte we have a long reputation for innovation in the field of stochastic modelling for insurers. Our team has been at the forefront of the introduction of market-consistent modelling concepts, and more recently has driven the development of market and credit risk models for firms' Solvency II internal models.

This innovative spirit is a fundamental component of XSG. The high-performance XSG modelling platform has been designed so that new models and methodologies can be very easily introduced into the solution, and we are continually investing in the research and development of new features.

Flexibility

XSG is designed to give users maximal control over the modelling process. Using the XSG tools and/or API, all aspects of the modelling process such as models, calibration assumptions and model parameters, can be easily and transparently modified to meet your modelling needs. XSG avoids the use of hard-coded settings and assumptions, opaque models and uninterpretable parameters.

Additionally, XSG provides users with access to libraries of both risk-neutral and real-world models which grow over time, rather than restricting users to a single proprietary model.
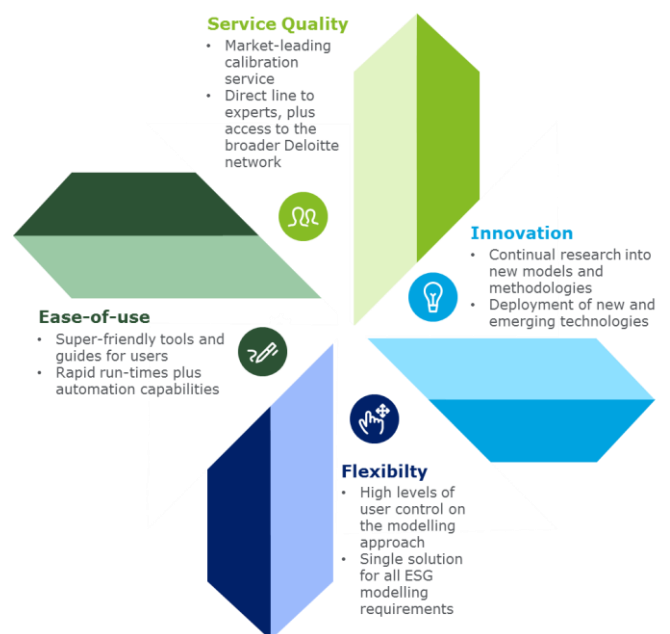
Ease of use

We believe modelling software should be simple and intuitive to use. Therefore, we have designed the XSG tools with the aim of making it as straightforward as possible for you to utilise all of the functionality that XSG provides, with minimal amounts of training and reference to user guides required. Of course, comprehensive user guides are also available!

In addition to XSG's core tools, XSG's automation tools and API enable you to set up your modelling processes so that the required amount of user interaction is minimised, enabling you to reduce operational risk and cut reporting timescales.

Service quality

We offer a calibration service with market-leading timescales. For example, we deliver bespoke XSG calibrations to one insurer by midday on the first calendar day of each quarter.

Furthermore, our service model provides you with direct access to the team of experts who research and develop XSG, rather than requiring you to interact with account managers. In addition, for international clients personalised and well-informed support can be provided by local Deloitte staff.

Service Quality
- Market-leading calibration service
- Direct line to experts, plus access to the broader Deloitte network

Innovation
- Continual research into new models and methodologies
- Deployment of new and emerging technologies

Ease-of-use
- Super-friendly tools and guides for users
- Rapid run-times plus automation capabilities

Flexibilty
- High levels of user control on the modelling approach
- Single solution for all ESG modelling requirements

Modelling with XSG

What types of model are available?

XSG's range of model libraries can provide you with access to three forms of stochastic economic models:

- Risk-neutral model library – for market-consistent valuation of insurance options and guarantees, and Monte Carlo-based asset pricing and hedging.

- Multi-period real-world model library – for multi-period asset allocation and investment strategy optimisation.

- One-step real-world model library – for regulatory and economic capital modelling (e.g. Solvency II SCR).

Risk-neutral models

Insurers make use of risk-neutral models for the valuation of options and guarantees embedded within their liabilities. XSG features a growing library of cutting-edge risk-neutral modelling methodologies.

Using our risk-neutral models, you can generate scenarios that achieve the following desirable properties:

- **Close fit to market prices:** The models are proven to be able to replicate market prices of derivative instruments spanning a range of term, tenor and strike rates, across a range of historic and stressed economic conditions. In this way, XSG is able to support regulatory requirements for market consistent valuation of liabilities.

- **Low leakage:** The sophisticated variance reduction techniques implemented in XSG mean that minimal sampling error is associated with generated scenario sets. This can lead to reduced computational burden for liability modelling systems, and greater reliability of results.

- **No exploding rates:** Our flagship interest rate models produces interest rate projections that exhibit distributions that avoid "exploding rates" – scenarios where interest rates become excessively large. This avoids computational and numerical impacts sometimes seen by insurers in downstream applications.

- **Support for negative initial yields:** Our flagship interest rate models admit any initial yield curve for input, including curves exhibiting negative rates. This is not possible for all rate models, yet is vital in the current era of low interest rates.

- **Realistic behaviour for index returns:** XSG includes equity models that feature distributions of returns that incorporate "fat tails", skew and instanteneous jump behavior, all of which are both observed in historic returns and are consistent with market implied distributions.

- **Consistent credit spread behaviour:** XSG's credit modelling approach is a ratings transition-based model that ensures scenarios for credit spreads relating to multiple credit ratings and borrowing terms are produced in a consistent manner, e.g. with lower-rated bonds offering higher spreads and being more volatile than similar higher-rated bonds.
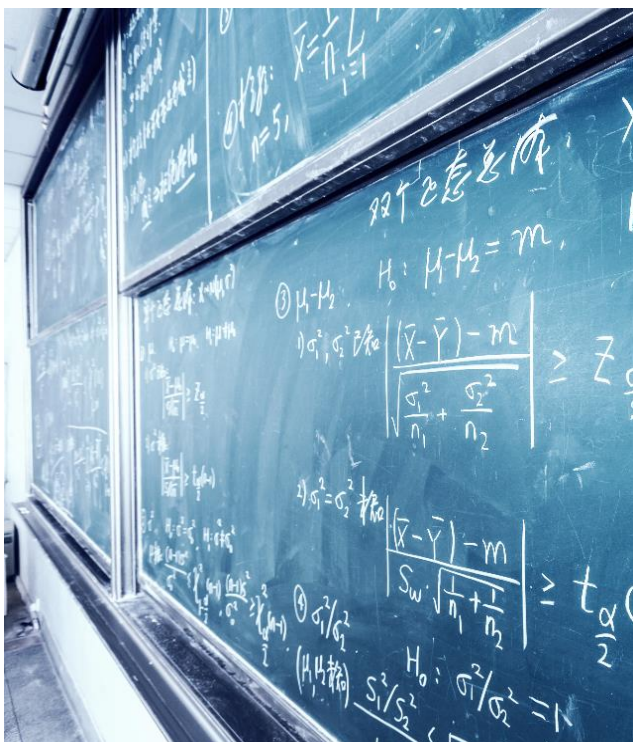
Modelling with XSG

Real-world models

Financial institutions can use the real-world models in XSG to produce realistic scenarios for future behaviour of economic variables. These scenarios can be used for purposes such as the quantification of risk over long time horizons, or identifying optimal investment strategies.

XSG's real-world models can be calibrated purely to historical data, so as to achieve projections that are consistent with history, while you are also able to transparently overlay your own views and assumptions if required. The open and flexible nature of the models makes it easy for you to understand their working and control their behaviour.

There are two available types of modelling approach for real-world modelling:

- **Generalised versions of the risk-neutral models**
  These are continuous-time models with risk premiums incorporated. These can be useful when the behaviour of the models is required to be understood in closed form.

- **Time series-based structural models**
  These families of models can provide you with a great deal of modelling flexibility and may better capture certain important real-world features and behaviour, since they are not constrained by mathematical limitations of differential equation-based models.

We have developed a family of real-world models tailored towards being easily adjustable, so as to enable you to overlay your own assumptions.
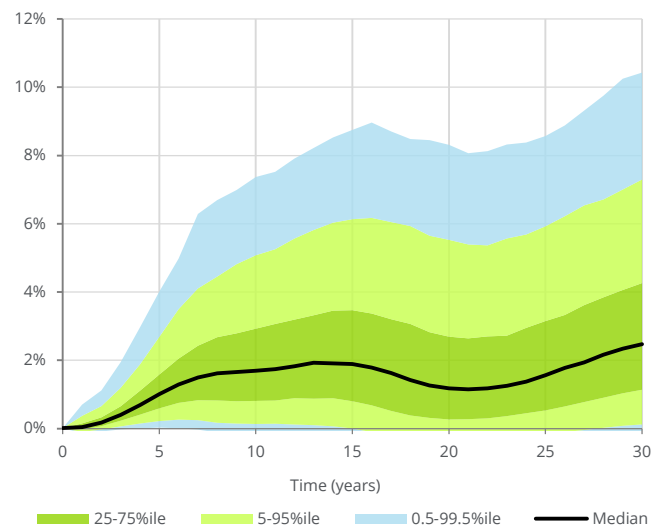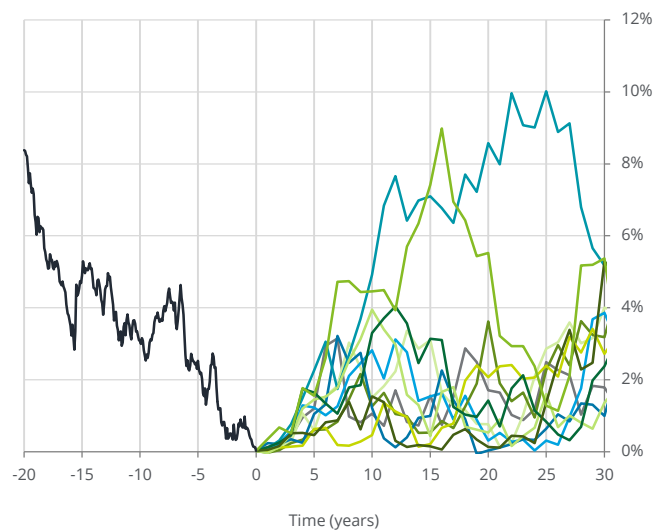
The XSG real world models produce realistic distributions of future values that are consistent with historic experience

Modelling with XSG

One-step risk models

Many insurers who choose to develop an Internal Model for calculating their capital requirements under Solvency II or similar regulatory regimes adopt a Monte Carlo approach for the modelling of their risks, which involves the calibration of risk models to historic data. These models are then used to generate tens or hundreds of thousands of scenarios for conditions in one year from the calibration date.

The XSG one-step risk models are based on generalised families of statistical distributions, and provides you with tools and methodologies for calibrating and validating models for market and non-market risks, so as to demonstrate consistency with historical experience – this is essential for demonstrating the statistical quality of the model. In particular, XSG's models are able to accurately reflect desired behaviour in the extreme tails of risk distributions. Dependencies between risks can be reflected through the use of copula models.

Supporting tools and models

The applications of Monte Carlo models within financial institutions are expanding all the time, and we continue to work on building supplementary tools and solutions that work with XSG to enable insurers to make the most of the solution. These include tools for:

- Granular asset-by-asset modelling

- Identification of optimal investment strategies

- Automation of the production of nested stochastic scenario sets and Least Squares Monte Carlo (LSMC) proxy model calibrations

Transformed AAA credit spreads – distribution fit

-1.6% -1.3% -1.1% -0.9% -0.6% -0.4% -0.2% 0.1% 0.3% 0.6% 0.8% 1.0% 1.3%

▬ Empirical   ▬ Fitted distrib.
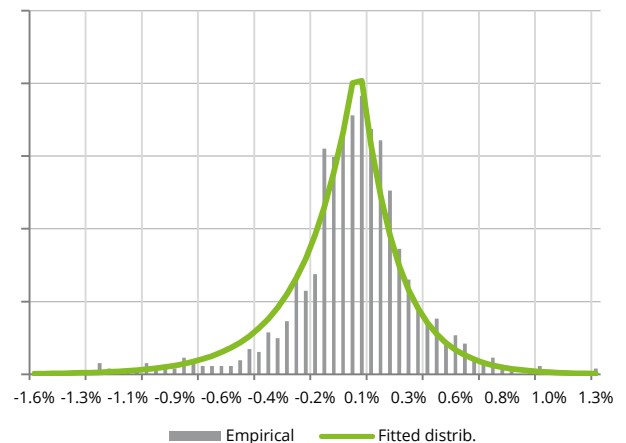
AAA credit spreads – Q-Q plot

● Empirical v. fitted quantiles   .... Y=X
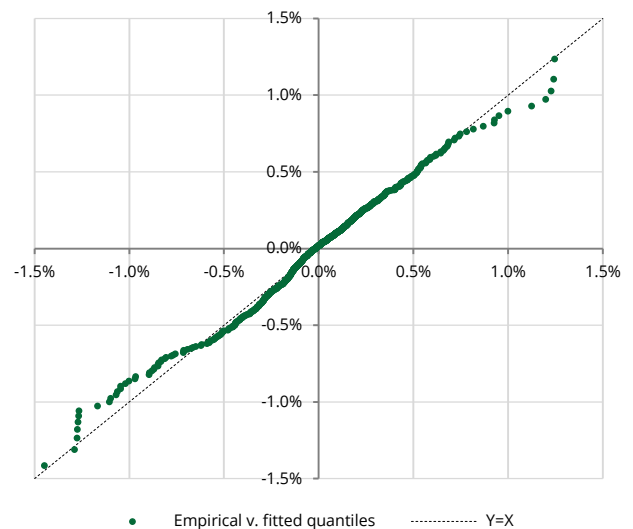
Through fitting statistical distributions, XSG is able to produce scenarios that achieve a close fit to historical data

Using the XSG software

What tools will you get?

As an XSG user, you will be provided with the full suite of XSG's powerful, easy to use desktop tools. They allow you to fully automate the scenario generation process, from model calibration to scenario simulation and finally to scenario validation. The tools are designed to be used by anyone, regardless of their level of expertise.

Calibrating and generating scenario files

The XSG Interface tool allows you to efficiently configure all aspects of a scenario file that you wish to produce. This includes:

- High-level run settings such as number of simulations and projection years

- The asset classes you wish to model and the models you wish to use

- The outputs that you wish to be recorded in the generated scenario files

- The data to which to calibrate the models to

Having populated this data, you can then trigger the calibration and generation of your scenario file.

If you wish to further understand the models and a particular calibration, each XSG model has a dedicated calibration tool which provides users with more information on properties of the model and allows them to carry out in-depth calibrations. These can help you to better understand each model's properties as well as the efficacy of the calibrations.

Each calibration tool displays various diagnostic information relating to the calibration to enable you to understand the calibration process and assess the adequacy of the fit.

You get unrestricted access to the full suite of powerful, easy to use desktop tools.
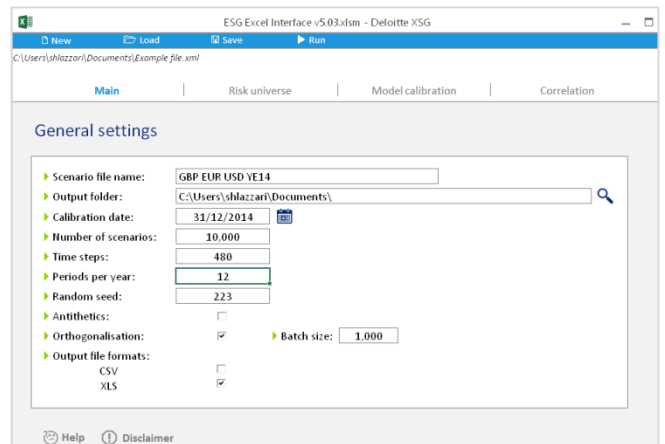
Front page of XSG Interface tool, showing high-level run settings
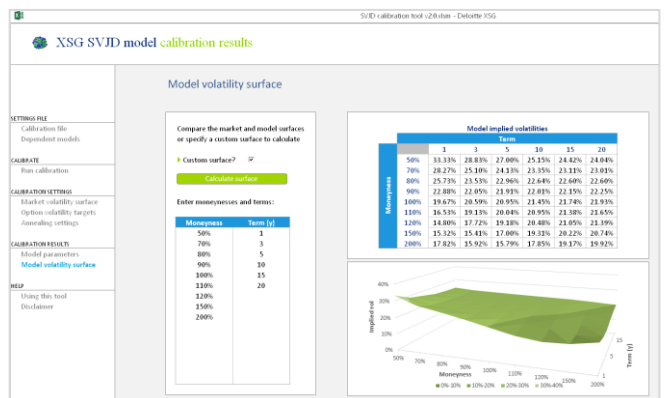
Calibration of SVJD model to equity implied volatility surface
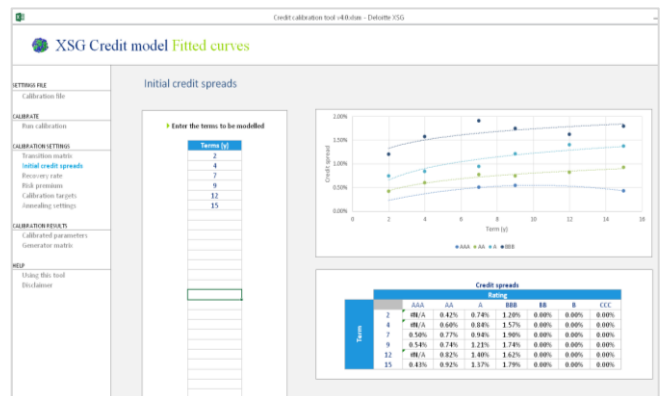
Calibration of credit model to market credit spreads

Using the XSG software

Validating scenarios

Once a scenario file has been generated, the XSG Validation tool can be used to specify validation analyses to be performed on the scenarios, and produce automatically-generated graphical reports based on these analyses.

Users are provided with a great deal of flexibility regarding the contents of the reports to be generated, with them being able to specify:

- The asset classes to be analysed, and the number of scenarios to be used

- What types of validation analyses are performed

- Analysis parameters – for example, the term/tenor combinations to be calculated for a swaption surface, and threshold levels for acceptable differences between actual and expected values

XSG's dynamic validation tools are designed to allow you to interactively analyse XSG scenario files in real time. You can specify and adjust the properties of a scenario file that you want to investigate, and the charts and tables in the tools will automatically update as required.

Automating ESG production

ESG users are facing requirements to produce increasing numbers of sets of scenarios. To support the efficient production of these files, the XSG batch generator tool allows you to automate the production of batches of risk-neutral scenario files. Using this tool you can:

- Specify sensitivities to be applied to a base scenario set.

- Configure a batch of XSG runs to be carried out.

- Trigger the calibration, generation and validation of the batch of scenario sets.

Customisation

All of our tools are Microsoft Excel-based, making it easy to transfer data in and out of them. The underlying XSG functionality is called up in these tools via the XSG API. The developer-friendly, fully-documented API makes it easy for you to adapt these tools if you so wish, or for you to build your own bespoke tools. The API also allows XSG to be called up from other systems such as data feeds or an ALM.
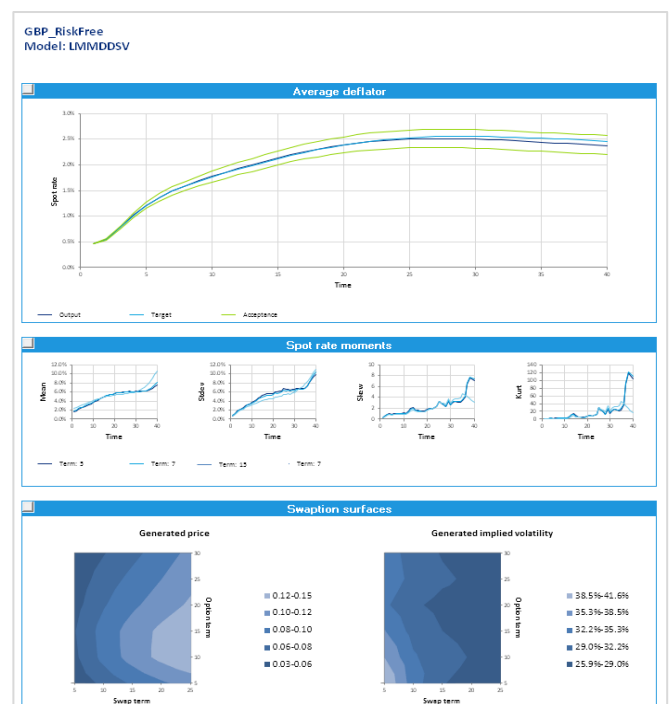
Example of a page from an XSG validation report

XSG's dynamic validation tools are designed to allow users to interactively analyse scenario files in real time.

About us and our clients

Why Deloitte?

We have the experience and expertise.
The XSG development team, led by the world-renowned Andrew Smith, has developed our in–house ESG since 1998 and strives to keep at the cutting-edge of stochastic modelling of insurance and market risks. Over the years we have worked with over 40 clients using our ESG software in Asia, America and Europe, and during this time we consistently delivered timely, high quality economic scenarios.

In addition to providing ESG software and calibration services to our clients, we also provide advisory and consultancy services to insurers to advise them on modelling best practice and solve challenging methodological issues.

We provide innovative solutions utilising our vast networks of experts.
The team that develops XSG are all either quantitative experts or technology professionals, and often both. We draw upon the expertise of the broader Deloitte Insurance and Technology teams to ensure our solution reflects the latest market and technological trends. Client support is provided directly by the development team, supported by insurance practitioners in our member firms for overseas clients.

Deloitte's broad understanding of clients' businesses and industries distinguishes us from our competitors. We have the industry knowledge and experience to build, maintain and deliver a high quality solution that meets your scenario generation requirements, and also the agility and know-how to deliver innovation and the solutions to hard problems.

A cost-effective solution.
We believe the pricing of the XSG solution is competitive. Furthermore our prices are also transparent – in particular, you are granted full access to the library of models and tools as part of the basic licence fee, without any extra charges.

ℹ️ For more information please get in touch with your usual Deloitte representative or email us at **UKDeloitteXSG@deloitte.co.uk**.

CREDENTIAL – UK INSURER: Revolutionising Scenario Production

⚠️ **The challenge:** This insurer's ambition was to produce 500 risk-neutral scenario sets on the first working day after each quarter end. The client required that the ESG solution integrate easily into their broader modelling system architecture and allow them to meet their ambitious reporting timescales.

💡 **Our insight:** We provided a solution as technically robust as the existing ESG, capable of producing the required number of files on time. We also offered a continuous support service during the critical period following each quarter end.
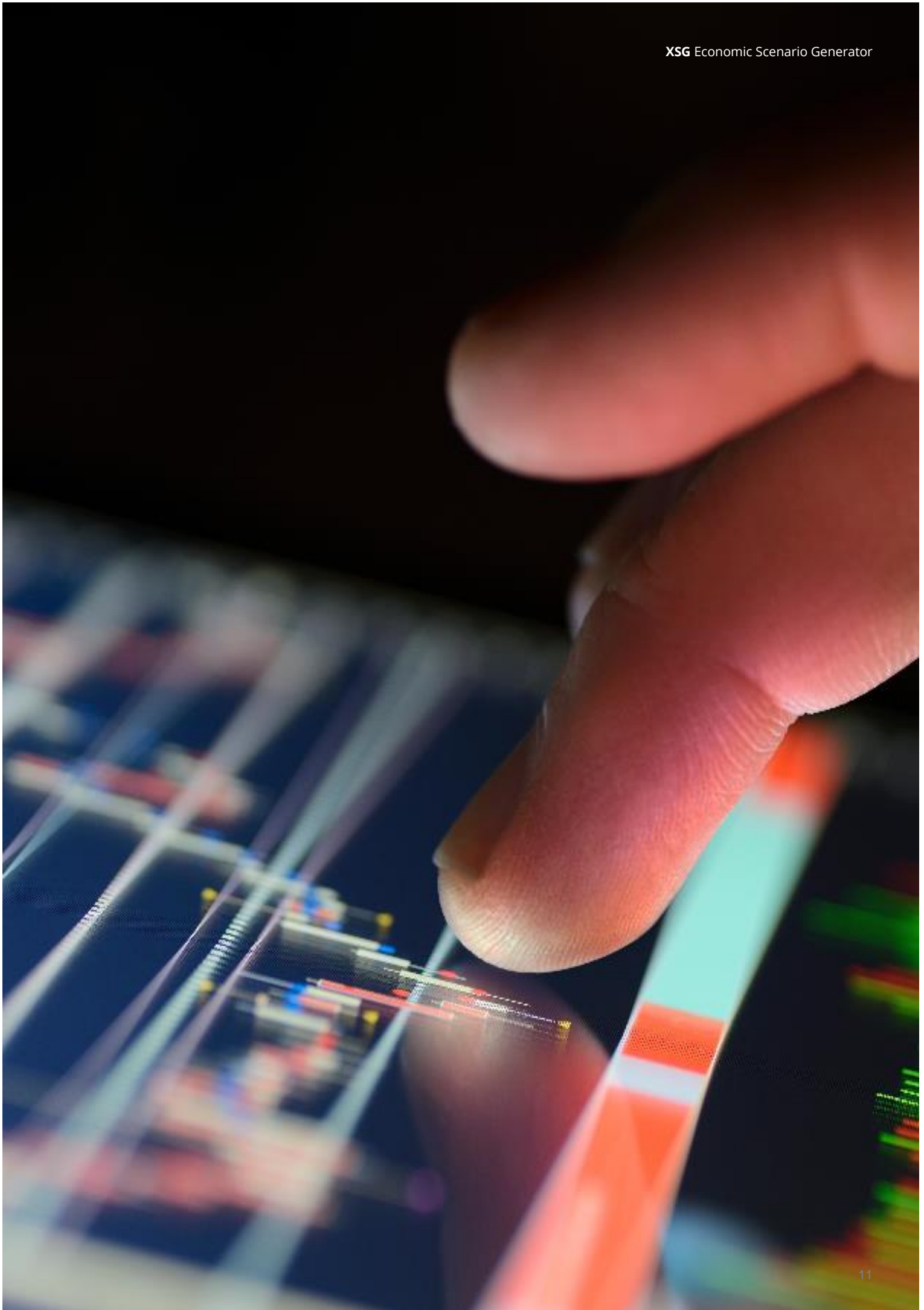
🔧 **The impact:** Minimal time delay – only a few hours between occurrence of each quarter-end and generation of ESG files, supporting a highly efficient financial reporting process plus full automation of the ESG file production process, reducing risk of occurrence of human error and freeing up actuarial resources for value-adding investigations.

CREDENTIAL – SWISS BASED INSURER: Streamlining Scenario Production

⚠️ **The challenge:** This insurance group sought an ESG to optimise the process across the group for generating real-world and valuation scenarios. It was vital to meet regulatory developments and the requirements of the company's internal model while being cost effective.

💡 **Our insight:** We provided a solution that enabled the insurer to use the same software for all scenario generation. The simple calibration tools and thorough documentation let them take the calibration process in-house without compromising the sophistication of the modelling.

🔧 **The impact:** The insurer took on the model, assumptions and outputs. They now produce their own scenarios and can show the regulator an in-depth understanding of the ESG's mechanics, methodology and outputs.

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