Willis Towers Watson

STAR RN

Risk neutral economic scenario generator

STAR RN places powerful economic models in an easy-to-use user interface which makes the process of generating risk neutral scenarios simple. STAR RN produces a key input for market-consistent balance sheets and a variety of valuation applications.

An introduction to STAR RN

STAR RN is a risk neutral economic scenario generator (ESG) and forms part of Willis Towers Watson's STAR ESG suite of economic modelling tools. A risk neutral ESG forms a vital input for any application requiring market-consistent valuation of financial options and guarantees. For insurers, this typically means valuing policyholder liabilities where there are embedded options and guarantees and where deterministic approaches won't work. The principles of market-consistent valuation are widespread in financial reporting and elsewhere, for example Solvency II, embedded values and guarantee pricing.

Other tools in the STAR ESG suite

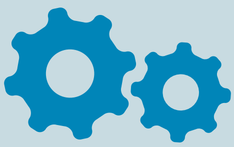
Risk neutral scenarios are useful for market-consistent valuations, but in other instances ESG modelling requires a real world model, for example, if you need a realistic, forward-looking view that takes into account both the historical and statistical behaviour of markets. The STAR ESG suite also includes the sister STAR RW model designed specifically for that purpose. More information on the full suite of STAR ESG tools is available on our website, or you can ask your regular consultant or contact us directly. Contact details can be found at the end of this brochure.

Why choose STAR RN as your economic scenario generator?

STAR RN is a modelling solution that offers you:

- Fast and powerful modelling in a single package
- A painless operational fit to your business that integrates and automates
- Support from a firm you can trust

Fast and powerful modelling in a single package



A painless operational fit to your business

The support of a firm you can trust

Fast and powerful modelling in a single package

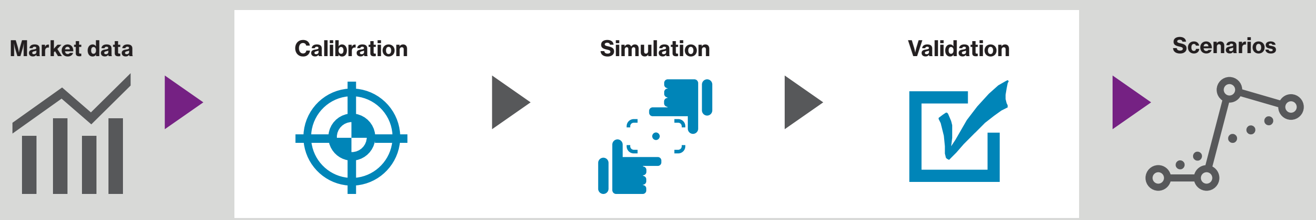
STAR RN makes use of advanced mathematical models which use well-tested academic research adapted to our specific requirements. It gives you the ability to calibrate risk neutral scenarios to your own data and assumptions using bespoke algorithms. This allows modelling in a multi-currency, multi-asset framework including equities and property, interest rates, credit, inflation and FX. The ability to build asset portfolios is also included, making the modelling process much simpler.

STAR RN can also simulate at high speeds using efficient simulation routines with variance reduction embedded and automated. By researching and building our own bespoke models in a dedicated platform, we are able to achieve high performance and ultimately deliver end results as quickly as needed.

Results need to be not just fast but accurate and supported by validation tests. STAR RN builds in a comprehensive range of standard validation tests. The built-in variance reduction techniques significantly reduce the amount of reruns that ESGs typically need to get good results.

All these features are combined into a single, powerful package.

Figure 1. **Fast and powerful modelling through calibration, simulation and validation**

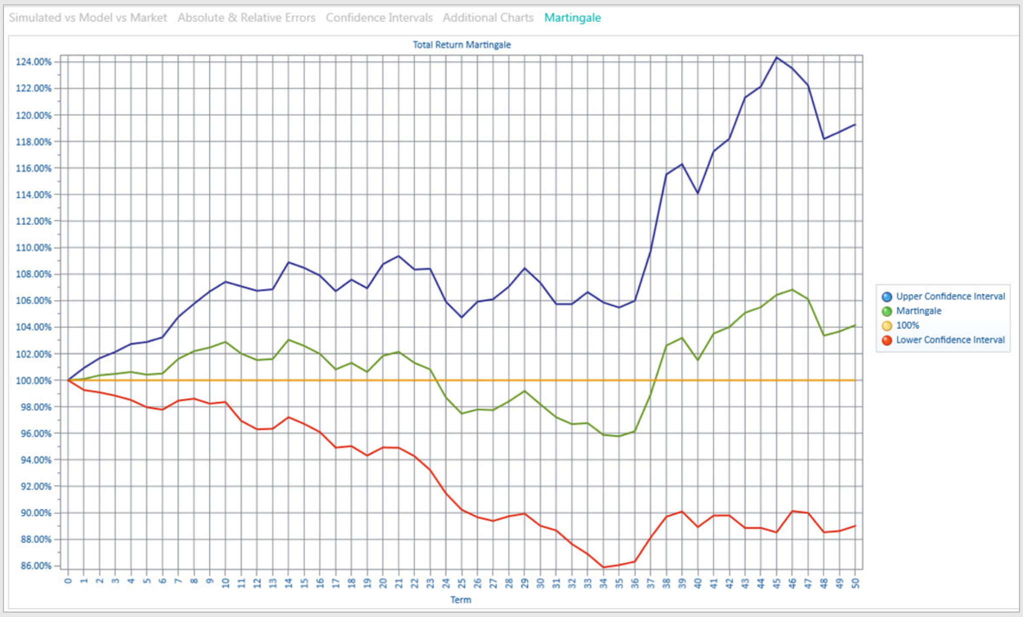


Variance reduction

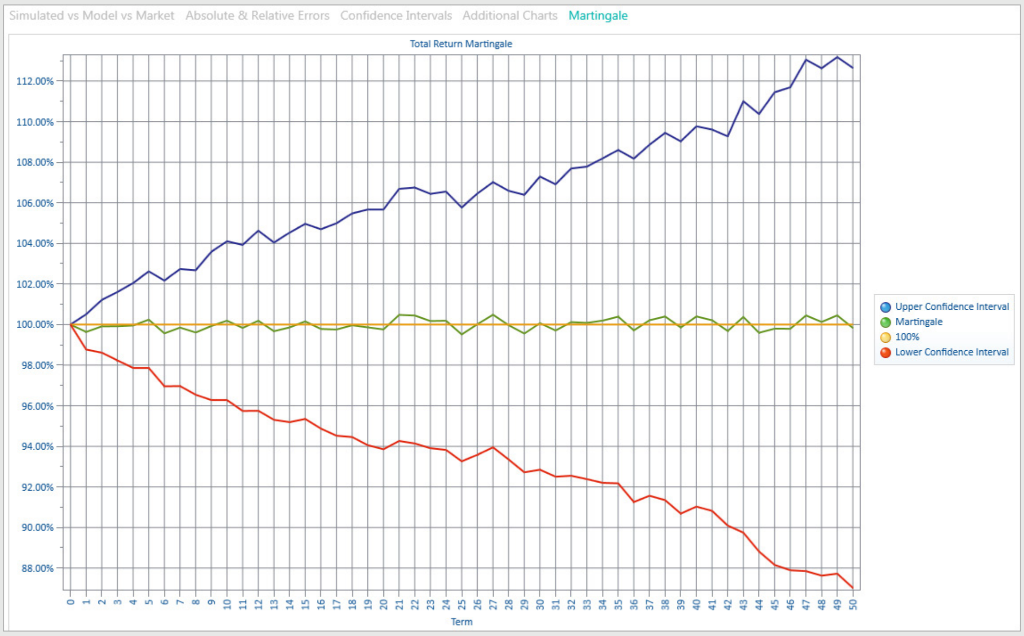
STAR RN incorporates a range of variance reduction techniques to improve accuracy without increasing the number of scenarios. Resampling is one such technique. It uses on-the-fly martingale testing to reduce random errors and improve the quality of scenarios.

Martingale test (green line) before resampling. The test shows significant deviation from 100%, indicating material pricing errors.

Figure 2. **Example of resampling**



Martingale test (green line) after resampling. Without increasing the number of scenarios, there is a significant increase in pricing accuracy.

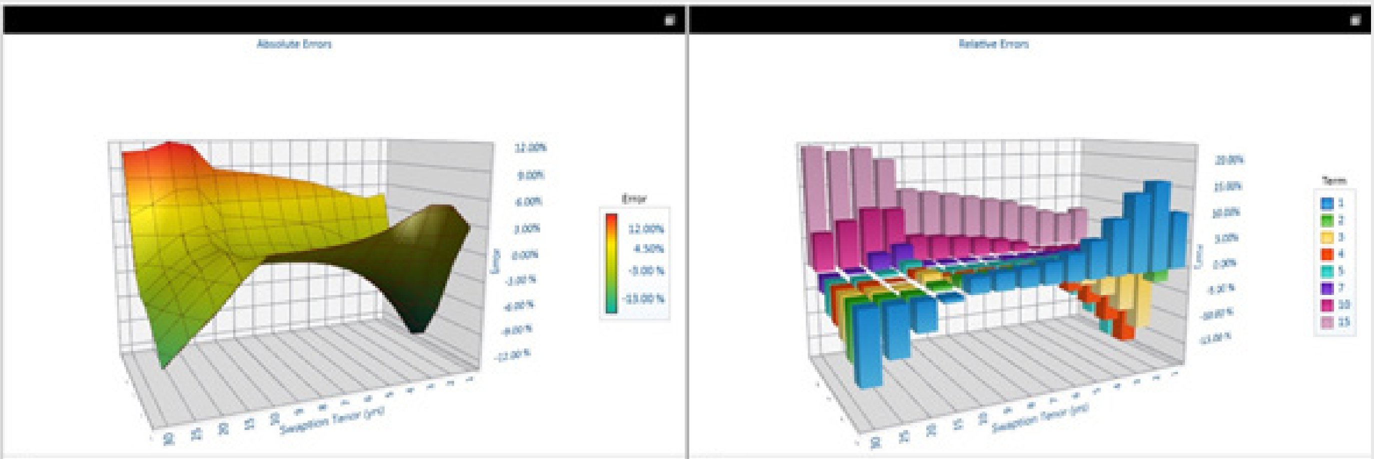


Other variance reduction techniques include refining the projection timestep, antithetic sampling and optimising the random number generation.

STAR RN features a bespoke user interface designed to support the entire process of generating market-consistent scenarios in an intuitive and easy-to-use environment.

STAR RN produces flexible outputs using graphical and tabular displays which can accommodate varying downstream requirements. Users can carry out and test their own calibrations, with STAR RN providing graphical and numerical output at each stage.

Figure 3. **Graphical and numerical output showing quality of calibration**



Data

Tenor

%	1	2	3	4	5	6	7	8	9	10	15
1	3.0124	5.5008	5.6578	4.5727	3.3751	2.6108	2.1747	1.9332	1.8204	1.6766	-0.5251
2	-1.5078	0.0502	0.8727	1.226	1.3709	1.522	1.2949	1.2904	1.2203	1.1098	0.6365
3	-7.5732	-5.516	-3.6649	-2.1386	-0.9487	-0.346	0.0505	0.2255	0.2988	0.267	1.2915
4	-11.3795	-8.3252	-5.7258	-3.8349	-2.4786	-1.5866	-1.0908	-0.8824	-0.8345	-0.8903	0.9244
5	-12.2327	-8.5453	-5.6151	-3.6947	-2.425	-1.5204	-0.9793	-0.7314	-0.6521	-0.6641	1.3732
7	-9.174	-6.6557	-4.2179	-2.517	-1.3332	-0.525	-0.0392	0.2071	0.3308	0.3871	2.8997
10	-2.2247	-2.2018	-1.1572	0.1456	1.3498	2.0444	2.5262	2.918	3.2269	3.5297	6.7805
15	4.8644	4.3897	5.0383	5.8664	6.6932	7.2024	7.6591	8.0692	8.4303	8.7911	11.534

Data

Tenor

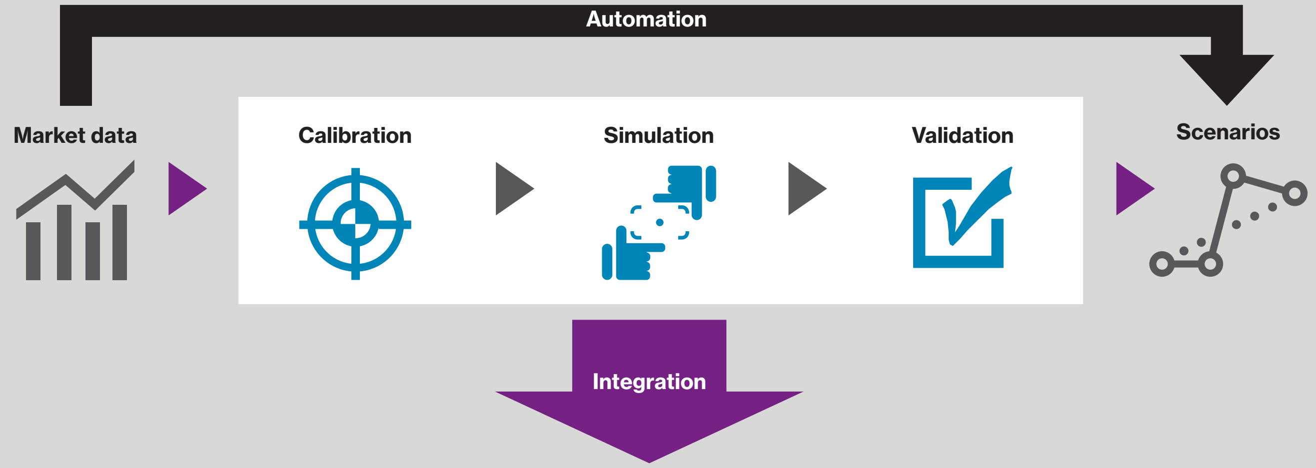
%	1	2	3	4	5	6	7	8	9	10	15
1	10.4523	16.4008	14.4148	10.1481	6.7421	4.8483	3.8388	3.2933	3.0255	2.7369	-0.8143
2	-3.6175	0.1088	1.7581	2.2772	2.4098	2.2233	2.1076	2.0505	1.9052	1.7102	0.9664
3	-14.1081	-9.7319	-6.2064	-3.5082	-1.518	-0.5404	0.0774	0.3403	0.4457	0.3949	1.9395
4	-18.2686	-13.0982	-8.8759	-5.8583	-3.7363	-2.3617	-1.6055	-1.286	-1.2068	-1.2806	1.3751
5	-18.0071	-12.587	-8.2539	-5.3913	-3.5079	-2.1851	-1.3988	-1.0589	-0.9227	-0.9374	2.0296
7	-12.8398	-9.2815	-5.8958	-3.5187	-1.8628	-0.7333	-0.0548	0.2892	0.4623	0.5422	4.3357
10	-3.1329	-3.0298	-1.5614	0.2011	1.8813	2.8634	3.556	4.1314	4.5994	5.0707	10.5978
15	7.3414	6.4784	7.4213	8.6832	9.9883	10.8161	11.5907	12.325	13.0118	13.7297	19.7974

A painless operational fit to your business that integrates and automates

STAR RN provides tools to automate the whole process of scenario production from data input to the final scenarios and is simple to embed into an efficient reporting process. This makes it ideal for any use requiring multiple sensitivities such as stress testing balance sheets or calibrating proxy models.

Higher standards for governance and ever-tightening reporting timescales create an increasing demand for tools to be integrated into a controlled workflow. STAR RN is designed for integration into your business at various levels. For example, scenario formats can be tailored for compatibility with different downstream systems to minimise additional processing. For deeper integration, STAR RN offers an exposed application programming interface (API) allowing it to be called by other systems, such as our proxy modelling software RiskAgility Proxy Modeller (RiskAgility PM) and our systems integration and workflow platform Unify, as well as third party software. RiskAgility PM directly integrates with STAR RN, automating the production of both stochastic and nested stochastic scenarios.

Figure 4. **STAR RN automates scenario production and integrates with third-party systems**



Support from a firm you can trust

Financial reporting is a critical business process and so you need to know that your software provider can give you the support you require.

An established product backed by an established firm

STAR RN forms part of the STAR ESG suite, comprising a range of tools used by our clients and by our own consultants globally for advising insurers, pension funds, sovereign wealth funds, endowments and foundations. Worldwide, our Investment business has over 900 consultants and the Risk Consulting and Software business has over 1200 consultants, advising clients on investment and risk. STAR RN benefits from internal and external support and challenge, enabling us to update it continuously to meet emerging needs.

Supporting our clients

Different clients have different needs and we tailor our approach to meet those needs. We supply ongoing training to our clients to refresh knowledge and explain new features, and align this to individual needs. We also provide support with challenges such as modelling a new asset class or optimising a calibration.

Our clients receive comprehensive documentation covering all aspects of STAR RN including a user guide, technical model descriptions and release updates. Each quarter we send our standard STAR RN calibration to our licensees and this comes with further documentation on the calibration process, assumptions and results.

We know our clients face increasing scrutiny from regulators, auditors and their own management and we provide the support needed to respond.

More than just software; we deliver business solutions

Willis Towers Watson is not just a software provider but a global consulting firm. We care about relationships and our mission is to change investment for the better. When you buy a model from Willis Towers Watson you are not just buying software from a provider but a solution from a business partner with a vision that we think resonates with our clients.

Our team of experts in diverse specialist fields and industry backgrounds stand ready to help you find the best solution for you.

Further information

To find out more, go to our website, email us at TW.INV.Contact.STAR.ESG@willistowerswatson.com or give us a call – we would be delighted to help you.

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About Willis Towers Watson

Willis Towers Watson (NASDAQ: WLTW) is a leading global advisory, broking and solutions company that helps clients around the world turn risk into a path for growth. With roots dating to 1828, Willis Towers Watson has 40,000 employees serving more than 140 countries. We design and deliver solutions that manage risk, optimise benefits, cultivate talent, and expand the power of capital to protect and strengthen institutions and individuals. Our unique perspective allows us to see the critical intersections between talent, assets and ideas – the dynamic formula that drives business performance. Together, we unlock potential. Learn more at willistowerswatson.com.

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