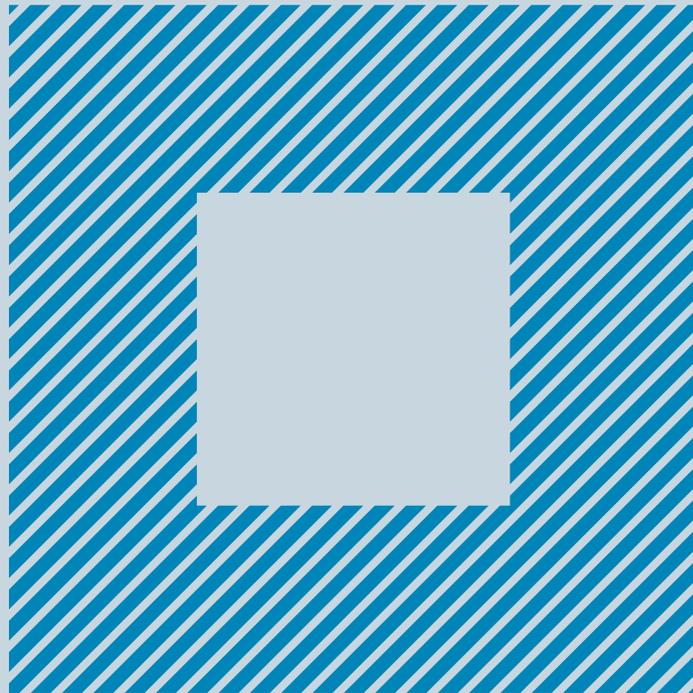


RiskAgility Proxy Modeler (PM)

Automate your capital modeling through faster proxy fitting and validation



RiskAgility Proxy Modeler (PM)

Automate. Validate. Accelerate.

RiskAgility Proxy Modeler (PM) brings together best practices from our extensive work across the insurance industry, as well as our wide-ranging experience in consulting, developing and using proxy models for capital modeling and asset liability modeling (ALM) purposes to standardize and automate all stages of the proxy modeling process, reducing the manual effort in what can otherwise be a resource-intensive process.

Proxy modeling has become a core component of a life capital model, having applications for the Internal Model, Own Risk and Solvency Assessment (ORSA) and enterprise risk management (ERM) frameworks in addition to ALM, capital projections and asset allocations. RiskAgility PM brings together in a single application the proxy modeling process, covering selection of stresses, production of scenario files, regression to identify a proxy model and validation of the robustness of the model.

For RiskAgility Economic Capital Aggregator (EC) users, this extends the functionality already embedded in that application. RiskAgility PM integrates directly with RiskAgility EC, with the output generated by RiskAgility PM directly uploadable into RiskAgility EC.

Willis Towers Watson has been developing proxy models in one form or another for nearly 10 years. RiskAgility PM provides insurers with two key advances:

1. The production of robust and validated proxies
2. An automated process to enable firms to meet accelerated reporting timetables arising across the world, and especially in Europe with the advent of quarterly regulatory solvency reporting under Solvency II

RiskAgility PM and Solutions for Life

RiskAgility PM is part of our Solutions for Life portfolio of integrated software, technology and consulting services – a holistic solution to managing the end-to-end risk reporting process.

For more information on Solutions for Life, turn to page 8 of this brochure or visit solutionsforlife.willistowerswatson.com.

Key features at a glance

- Automates the choice of stresses
- Automates the generation and validation of economic scenario generator (ESG) scenarios for stochastic models, even with third-party ESGs
- Undertakes Least Squares Monte Carlo (LSMC) modeling for stochastic models
- Automates proxy model fitting
- Validates proxy model fitting
- Provides flexibility to integrate with and improve your existing capital model process
- Can be integrated into automated workflows by using its application programming interface (API)

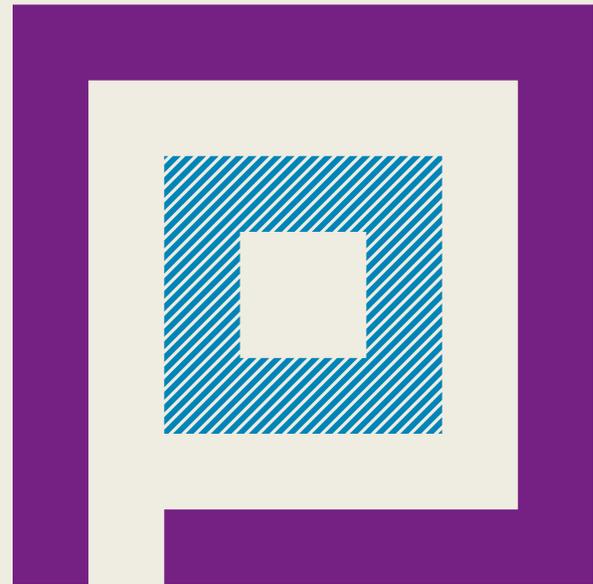


Figure 1. Stages of proxy model construction



Calibrating robust proxy models has been a major challenge

The Monte Carlo one-year value at risk (VaR) approach to economic capital is becoming the established norm throughout the life insurance industry since it was first implemented by Willis Towers Watson. The approach relies upon the ability to estimate the value of the balance sheet millions of times under a large number and wide range of stressed scenarios (or risk factors). Since this is infeasible with cash-flow projection models, proxy models, representing the value of the balance sheet under stress, are used instead. The most common proxy models are polynomial loss functions of the risk factors (as used in RiskAgility EC). Early proxy modeling used what has become known as “curve fitting” to fit a polynomial proxy against modeled values; more recently, LSMC has become the accepted best practice approach to regress the proxy against modeled values.

Proxy modeling, and its validation, can be a manual process and is resource-intensive. Notwithstanding the challenge of running hundreds or thousands of valuations, there is the question of identifying the choice of stress assumptions and the form of the polynomial that optimally fit the assets or liabilities, and the general problem of automating the workflow described above.

RiskAgility PM helps you overcome this challenge

RiskAgility PM overcomes this challenge in two ways:

- It improves the accuracy of the proxy model calibration, using advanced algorithms, such as Lasso and orthogonal polynomials, to ensure the optimal choice of proxy model. Important interactions between risk factors are captured, even in the tails. This allows the proxy model to be used robustly for applications such as ERM or with-profit fund management.
- It automates the proxy model calibration process, creating a seamless workflow from the construction of the stresses through production of the required scenario files by integrating with ESGs, the algorithms designed to construct the proxies and the automatic creation of validation reports.

RiskAgility PM highlights

- Calculates the terms included in the loss function using automatic algorithms
- Eliminates expert judgement from the selection of risk stresses and loss function fit
- Uses automated validation metrics
- Integrates with Willis Towers Watson software products RiskAgility EC, RiskAgility Financial Modeler (FM) and STAR RN (our risk-neutral economic scenario generator) to form a fully integrated capital modeling suite
- Works with third-party ESGs, allowing you to mix and match with your existing software investments
- Works with both for-profit and nonprofit business
- Contains a .NET API to allow integration into automated end-to-end processes using Willis Towers Watson’s Unify



Key features

Automating the choice of risk factor stresses

RiskAgility PM allows you to identify which risk variables you want to include, and the number and range of stresses to apply. It then constructs stresses automatically based on these parameters. Sobol sequences are used to ensure a global, efficient spread of the stresses across the risk space identified.

Automating the generation of ESG scenarios

To produce the scenario files necessary to run the cash-flow projection models under stress, RiskAgility PM is designed to automate the production of scenario files using an ESG such as STAR RN. RiskAgility PM will also work in conjunction with a third-party ESG with an exposed API, specifying the calibration requirements to produce the required scenario files.



Automating proxy model fitting: robust curve fitting or LSMC

RiskAgility PM can be set up to work in either curve-fitting or LSMC mode to allow for deterministic or stochastically modeled liabilities. The tool automates the choice and calibration of loss functions using algorithms such as Lasso and orthogonal polynomials that achieve an optimal balance between fit and complexity, with two main benefits:

- An accurate calibration is achieved with less computing time, making the process faster and reducing IT spend.
- Expert judgement is removed in the proxy model calibration, resulting in a much faster time for undertaking and validating the fits.

In the absence of these algorithms and automation, expert judgment would be necessary, which would significantly slow the calibration process and would tend to produce poorer results than the algorithms.

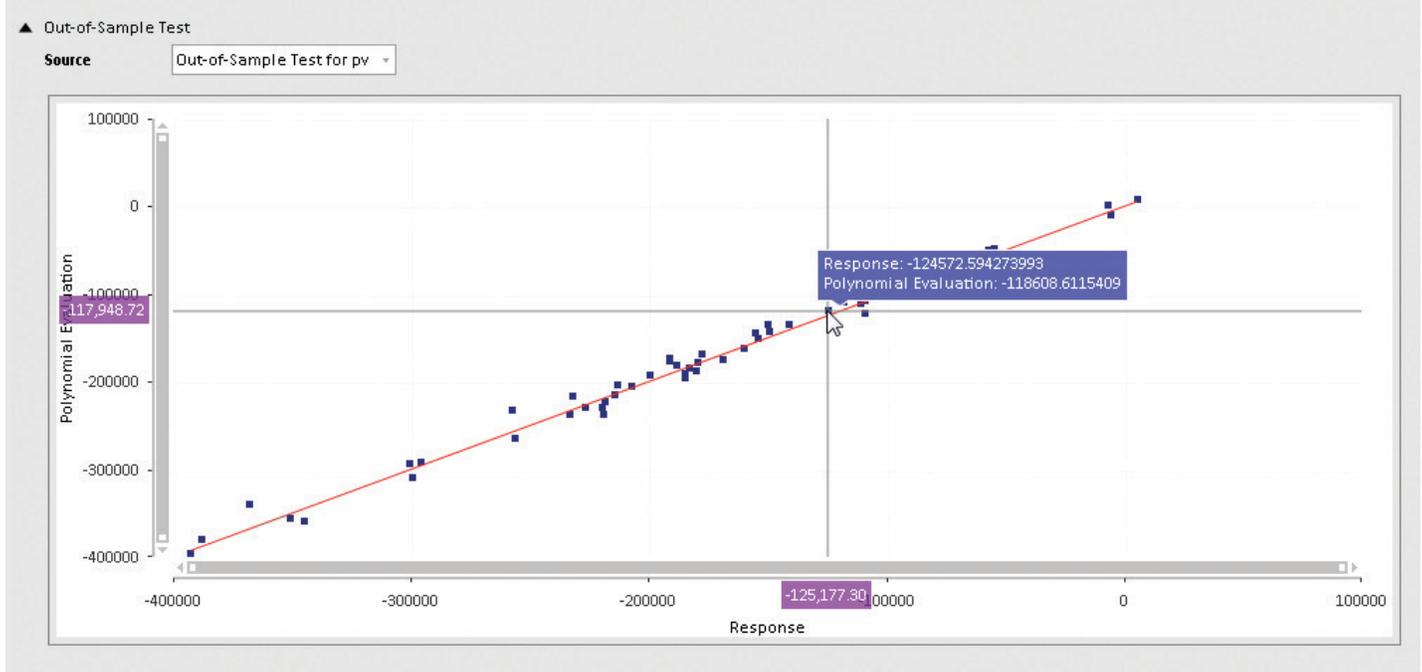
Proxy construction really involves two key questions:

- Identification of the proxy form, which is difficult (and where do the algorithms come in?)
- Selecting the parameters for a given form

Finally, removing the expert judgement — which is necessarily manual — enables the automated workflow necessary to hit reporting timetables.

RiskAgility PM can be set up to work in either curve-fitting or LSMC mode to cater for deterministic or stochastically modeled liabilities.

Figure 2. Out-of-sample validation graph produced by RiskAgility PM



Validating the proxy model fit

The final step in the process is validation. RiskAgility PM produces automated validation reports demonstrating the proxy model fit, including in-sample and out-of-sample testing.

The validation reports are necessary to meet the model validation requirements under Solvency II and other equivalent standards worldwide. By being embedded in the application, they replace the need to develop ad hoc spreadsheet validation tools while still providing proof of robustness for management, regulators, auditors and reviews.

RiskAgility PM is flexible

RiskAgility PM has a flexible modular design and contains an API allowing you to do the following:

- Integrate it with other Willis Towers Watson software products, and mix and match with existing software investments. This not only reduces implementation cost and time, as existing processes can be built on rather than replaced, but also enables the software to be used in automated workflows to streamline and replace manual processes.
- Adapt a transitional approach to LSMC modeling, incorporating selected features of RiskAgility PM into your modeling framework to leave the path open to future improvements.



Better economic capital modeling using LSMC

For stochastic models, RiskAgility PM can use LSMC to improve the proxy model fitting process.

LSMC is a proxy modeling technique very similar to loss function fitting. It is based on a technique developed by Longstaff and Schwartz* to solve problems in the banking sector arising from the valuation of complicated financial instruments.

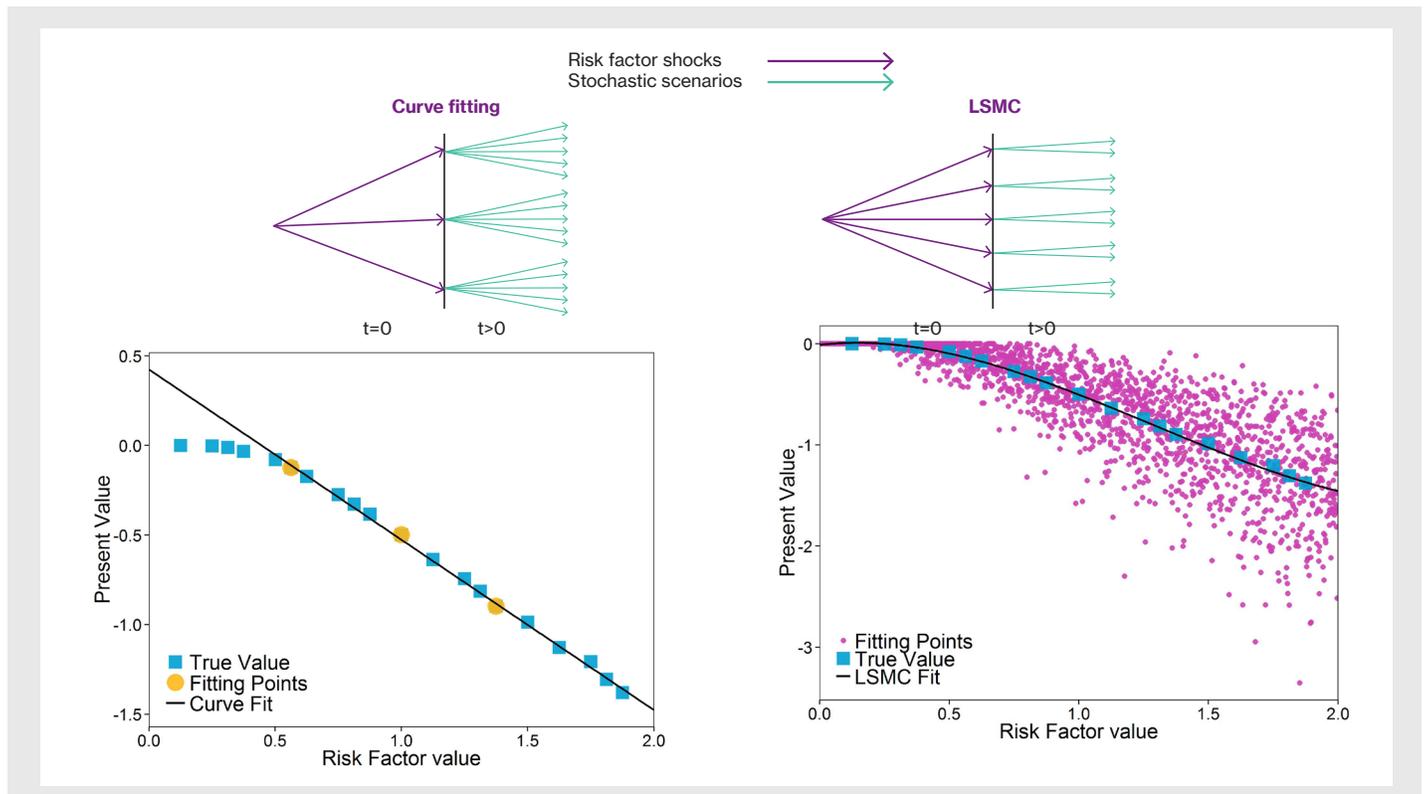
The key idea is to undertake a large number of valuations using very few stochastic scenarios. This is in contrast to curve fitting, which uses a small number of accurate valuations.

LSMC finds a loss function using least squares regression on these valuations. Longstaff and Schwartz showed that this loss function converges to the true liability function.

The LSMC approach has many benefits over curve fitting:

- Global accuracy is improved. LSMC converges to the polynomial loss function with a smaller budget of stochastic scenarios than curve fitting. A wider range of risk factor stresses can be used, improving the fit in the tails. The benefit of improved global accuracy is the ability to use loss functions for roll forward or what-if scenarios more accurately and for a longer period of time.
- Improved run time because LSMC is significantly faster than curve fitting. Past projects have resulted in a run-time reduction of over 10 times with improved accuracy. The faster run times lead to savings in people, hardware and software costs.
- A more automated process is possible with LSMC. RiskAgility PM automates the production of joint risk factor stresses, the ESG scenarios and the loss function fitting. No expert judgement is required in the selection of joint stresses or the proxy model fitting.
- Improved validation metrics provide proof for senior management, regulators, auditors and internal reviews.
- It is consistent with a curve-fitting approach because all current assumptions can be maintained. Therefore, existing ALM, ESG, risk definitions and aggregation tools can be used with LSMC.

Figure 3. Key differences between curve fitting and LSMC



*Longstaff and Schwartz, "Valuing American options by simulation: a simple least-squares approach," *Review of Financial Studies*, 2001

Better ALM using LSMC

RiskAgility PM and LSMC work alongside your existing ALM systems to resolve questions that were previously impractical to answer.

Modeling the effect of asset allocation on the cost of guarantees and solvency position

RiskAgility PM allows you to investigate the effect of management actions, such as the Equity Backing Ratio (EBR).

The approach used is to add the EBR as a risk factor in RiskAgility PM and vary the EBR in each stochastic scenario. RiskAgility PM will then produce a loss function modeling the effect of EBR on the balance sheet.

This loss function can be used with different levels of EBR to measure the cost of guarantees and the Solvency Capital Requirement (SCR), and hence, to answer questions like these:

- How does the asset allocation affect the cost of guarantees and solvency position?
- What is the effect of specific asset purchases or programs?

- How should the asset allocation change in the short term to manage the cost of guarantees and solvency position actively?
- What management actions should you use and assume for long-term asset allocation?

The advantage of this approach is that only one ALM run is necessary, removing the requirement to undertake and manage many what-if runs. RiskAgility PM provides significant automation in the process, including the calculation of joint stresses, automation of the ESG and the loss function fitting.

The approach can be extended to investigate management actions other than the EBR. Used in this way, RiskAgility PM becomes a very powerful tool to develop real-life asset allocation strategy and model assumptions. Being able to view the market-consistent embedded value, cost of guarantees and SCR as a function of management levers is very effective in understanding the dynamics of liabilities.

These techniques mean you can move from modeling to managing with-profit guarantees.

Figure 4. Modeling the effect of the EBR on the balance sheet and probability of ruin

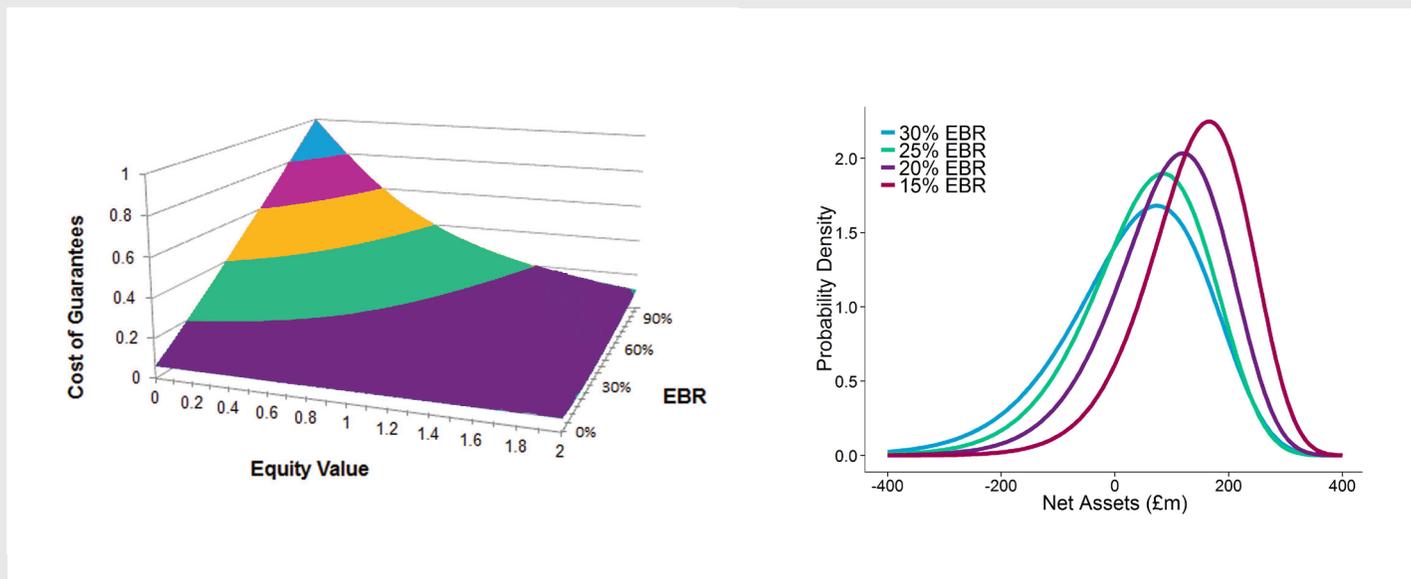
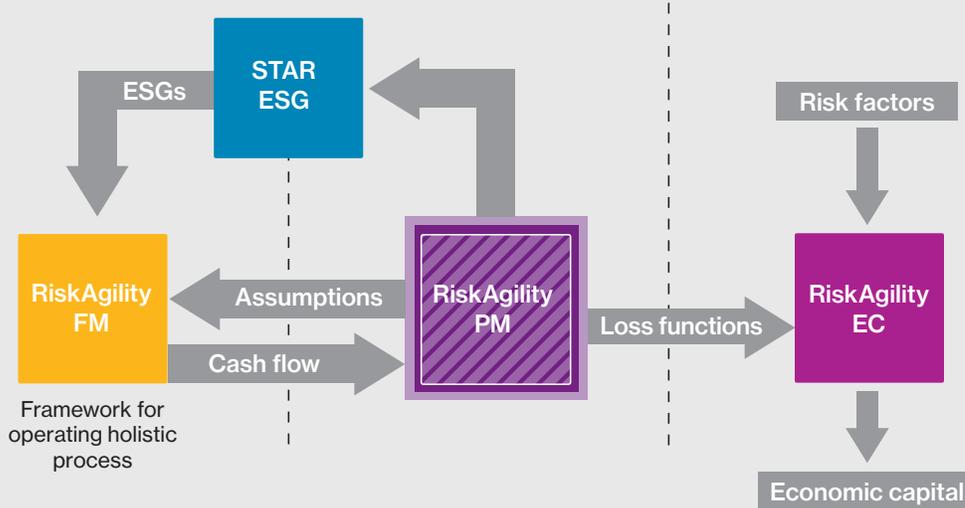


Figure 5. **Integrated capital modeling suite**



A fully integrated capital modeling software suite

RiskAgility PM is one of the capital modeling solutions within Willis Towers Watson's Solutions for Life (see page 8). It can be used alongside the other RiskAgility software programs (RiskAgility FM and RiskAgility EC) and your existing software:

- **ESGs** work with STAR RN or third-party ESGs
- **Cash-flow models** such as RiskAgility FM or others
- **EC aggregator** has a direct link to RiskAgility PM

Integration with STAR ESG RN

STAR RN is part of the STAR ESG product suite and generates risk-neutral market-consistent scenarios for major asset classes, such as interest rates, credit spreads and equities.

RiskAgility PM directly integrates with STAR RN, automating the production of both stochastic and nested stochastic scenarios.

RiskAgility PM also automates third-party ESGs. It includes a run manager able to automate a third-party ESG and management of the ESG assumptions. It can work in conjunction with a third-party ESG to produce nested stochastic scenarios.

Integration with RiskAgility EC

RiskAgility PM integrates directly with RiskAgility EC. The benefit of this is a robust, automated process for economic capital modeling using proxy models, from the setting of assumptions through to running the ESG, calibrating the proxy model and calculating the economic capital result.

Integration with your automated workflow

RiskAgility PM contains an API that enables it to be embedded into an automated workflow process, for example, using Willis Towers Watson's Unify product.

The main benefit is that this enables a significant change in the role of the end user. End users are no longer required to produce the proxy function fits themselves; instead, their role becomes a reviewer of the fits, and this change in role provides significant time and cost savings.

Why Willis Towers Watson?

Willis Towers Watson is the insurance industry's leading risk specialist, with extensive experience assisting clients around the globe in:

- **Market-consistent valuation techniques**, including the calibration and use of ESGs
- **Liability modeling**, for all types of insurance business
- **Economic capital modeling** and implementation
- **Advanced modeling techniques** such as LSMC
- **Deploying and embedding these techniques** as part of an enterprise risk framework

We can provide the advice, training and support you need to deploy a proxy modeling solution in your company in all the areas needed, from start to finish. As your business needs change, we can help you adapt your approach.

We also provide technical and implementation services for installing RiskAgility PM and integrating it into your company's enterprise framework.

A holistic approach to the wider risk reporting process

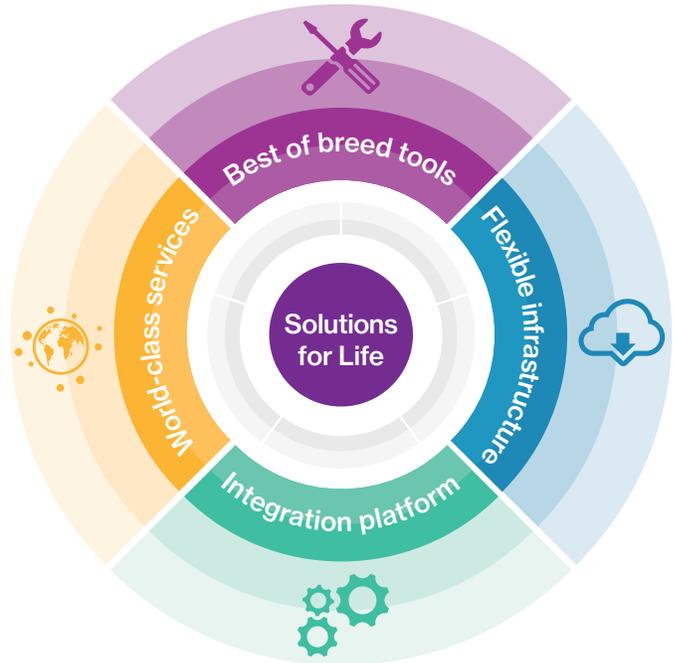
Solutions for Life

Solutions for Life is a portfolio of integrated software, technology and consulting services for life insurers that ensures your risk and actuarial processes adapt to meet changing business requirements – enabling you to save time and money, comply with regulatory demands and optimize legacy systems.

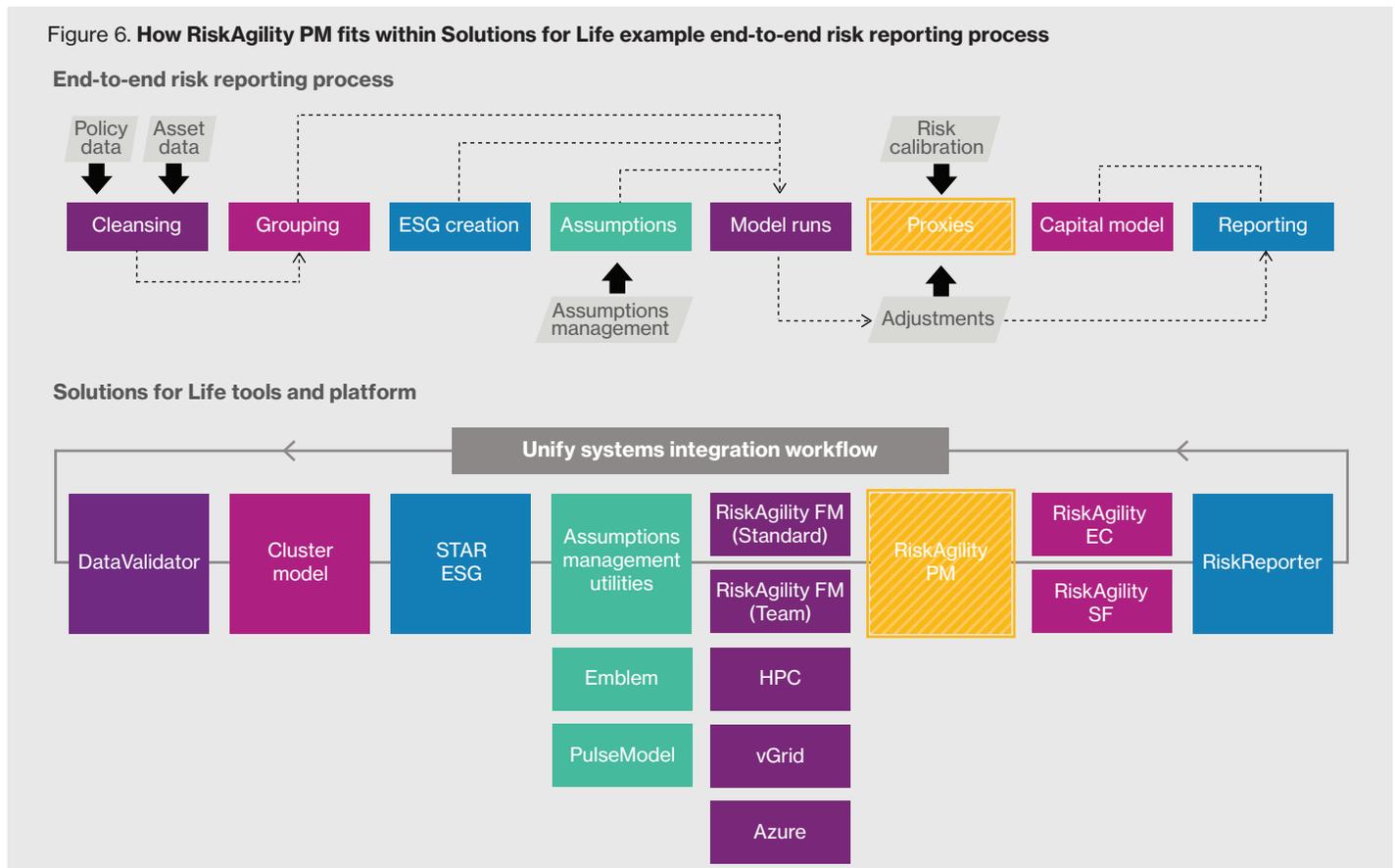
It is made up of four main components:

1. Best of breed software tools
2. Flexible infrastructure
3. Integration capability
4. World-class advisory and support services

Solutions for Life breaks down barriers, solves problems and provides confidence through accuracy, performance and control, by employing industry thought leadership and advanced technology. For more information, visit solutionsforlife.willistowerswatson.com.



Solutions for Life end-to-end risk reporting process



For more information

Visit: willistowerswatson.com/riskagility-pm

Contact: software.solutions@willistowerswatson.com

Follow us on Twitter: [@WTW_ins](https://twitter.com/WTW_ins)



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, optimize 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.



willistowerswatson.com/social-media

Copyright © 2017 Willis Towers Watson. All rights reserved.
WTW-GL-17-PUB-6087h2b

willistowerswatson.com

Willis Towers Watson