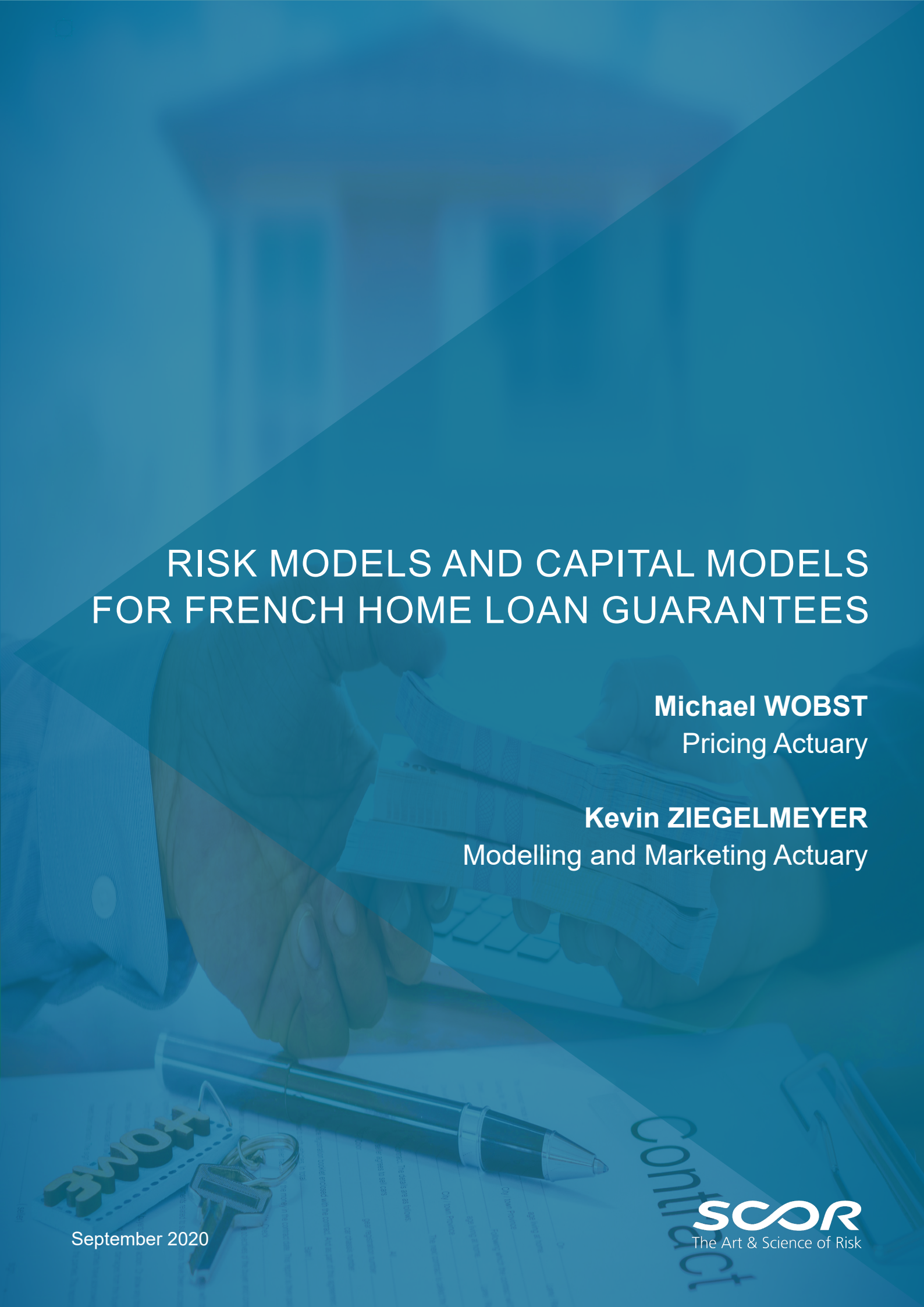
RISK MODELS AND CAPITAL MODELS FOR FRENCH HOME LOAN GUARANTEES

Michael WOBST
Pricing Actuary

Kevin ZIEGELMEYER
Modelling and Marketing Actuary



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SCOR
The Art & Science of Risk

RISK MODELS AND CAPITAL MODELS FOR FRENCH HOME LOAN GUARANTEES

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I. EXECUTIVE SUMMARY

This SCOR memo sheds light on a key product of the French home loan market, namely “caution” guarantees. They are commonly used by many individuals when they take out a loan to buy a house or an apartment. This guarantee ensures the lending bank would recover their debt in case of default of the borrower, even if the value of the purchased property has declined.

The issuers of such guarantees are professional risk carriers, whether licensed as insurance companies or as specialized credit institutions. They obey rigorous underwriting and risk-management processes and are subject to international capital standards (Solvency II, Basel III) that ensure their resilience in case of a major stress like the COVID-19-related crisis we are currently facing.

The “caution” guarantee has been a growing success for many years, being a very cost-efficient alternative to a mortgage.
Issuers of the guarantees ensure such competitiveness through a large mutualization, and through the support of reinsurance as a capital management tool. By protecting the issuers against the most adverse scenarios, reinsurers are left with the most sensitive challenge of assessing and pricing the low frequency scenario.

In this SCOR Memo we share some key issues related to this difficult topic. After an overview of how the home loan guarantees work in France, we will investigate the Solvency II and Basel III models and provide some further actuarial considerations for managing this product.

II. THE FRENCH HOME LOAN GUARANTEE (“CAUTION”)

A. A THREE-LAYER PROTECTION

In France, when applying for a loan to buy a real estate asset, a person needs to demonstrate their financial soundness with an initial capital contribution and a high enough regular income. Banks also require the borrower to buy borrower insurance to cover any health-related risks (death, disability) and to provide a collateral, either the house (mortgage) or a financial guarantee (surety insurance called “caution” in French).

1. The borrower’s solvency

Before granting a loan, banks will closely assess the financial and professional situation of the borrower. Only people with a low risk to default will be granted a loan. In France, unlike the US FICO score, there is no scoring system tracking a person’s financial history.
French banks rely much on the debt-to-income ratio and the loan-to-income ratio[1] as quantitative indicators. They rely less on the loan-to-value indicator unlike some other markets. Latest recommendation from the French financial advisory board[2] is to limit loans to a maximum duration of 25 years and a maximum debt-to-income ratio of 33%.

2. Borrower insurance

On top of this selection process, banks will usually require the borrower to buy an insurance policy to cover against their loss of income, as a result of death and disability risks.
This protects both the bank and the inheritors in case of death, the insurance taking in charge the reimbursement of the whole loan amount. In case of disability, the insurer’s commitment ranges from the payment of some instalments to the payback of the full amount depending on the ability of the insured to keep on working.
Borrower insurance is usually provided by the bank’s insurance partner, yet can be purchased from any other insurance companies.
The premium is a percentage of the loan amount, paid monthly for the duration of the loan. Layoff is rarely included in the coverage provided by borrower insurance, yet unemployment risk is mitigated by the French welfare system that is more protective than in some other western countries.

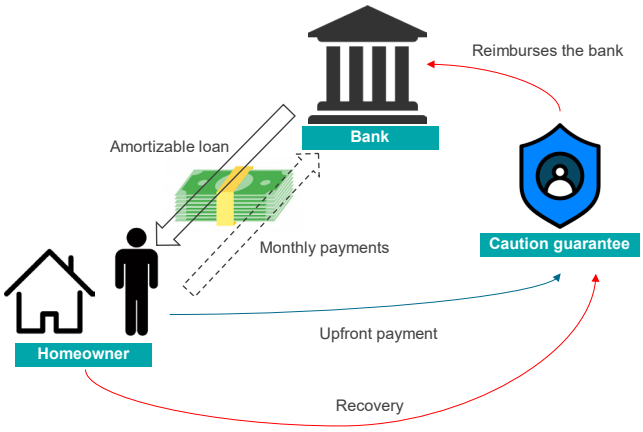
3. Security on home loans

The most conventional security or collateral to home loans is the mortgage. It is triggered when the borrower is unable to pay the instalments due. The bank is then designated as the owner of the real estate property. One should note that, in France, mortgage is managed by notaries, at a cost.

In France, an alternative to a mortgage has been offered for 40 years and has now become more popular than a mortgage (see graph on the next page).
This alternative is a guarantee (called a “caution” in French) delivered by a financial institution that can be either an insurance company or a bank which agree to pay back the loan to the bank in case of default. The guarantee issuer is then entitled to find some compensation by the borrower, including through the sale of the property.

B. FUNCTIONING OF THE GUARANTEE ON HOME LOANS

The premium for the “caution” guarantee is paid upfront by the borrower.
The beneficiary of the insurance is the bank granting the loan. The covered event is the default on the loan. If that happens, the payout to the bank is equal to the whole loan outstanding amount.



The way the guarantee works

1. See the section “ Some figures on French Home Loans” for definitions
2. HCSF, December 2019

1. Covered events

The coverage of the guarantee is called after a certain given number of unpaid installments (usually one to four depending on the contract).
The coverage, triggered by unpaid installments, relates therefore to the insolvency of the borrower most often due to a loss of income (following for example unemployment or a divorce) or due to the borrower's bad financial planning.
On the other hand, when the insolvency comes from an income loss due to a health issue, the borrower will resort to the borrower insurance that will indemnify the bank and no recovery process will be engaged against them.

2. Subrogation and recoveries

The loan guarantee is sometimes only triggered if some losses remain after the bank has used all the possible procedures for recovery. It is however more common that the insurer subrogates the bank in their right to recover the loss. In this case, once the guarantee has been triggered and the bank is indemnified, the insurer can seek compensation on the whole wealth of the borrower using legal procedures.
This is the same process as for a conventional mortgage. In case of an economic crisis the insurer may also be able to wait with foreclosures until the house prices have recovered. However, the insurer and the borrower would first consider a renegotiation of the repayment terms. A deduction from wages can sometimes be agreed. The sale of the real estate property would otherwise offset the main part of the payout. The property value is therefore a key variable to determine the ultimate risk for the insurer.

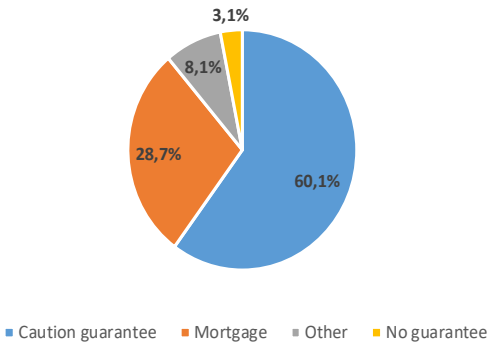
An advantage of a loan guarantee compared to a mortgage, from the bank's point of view, is that they receive the money immediately in case of a default whereas a mortgage leaves them with cumbersome recovery processes and the uncertainty of recovering the outstanding loan amount, in particular due to the risk of declining property values.

3. Profit sharing in case of no loss

The premium of the loan guarantee is paid upfront by the borrower. Some policies provide some payback to the borrower when the loan is fully reimbursed.

C. DISTRIBUTION AND MARKET

The home loan guarantee is the preferred guarantee when financing a real estate acquisition by a loan. 60% of French home loans are insured by such a "caution" whereas around 30% uses a mortgage.



Guarantee types on outstanding loan amounts (2018)

Source: Publication ACPR,
Le financement de l'habitat en 2018

In France, the market leader is Crédit Logement, a financing company jointly owned by the main French retail banks[3].
The other players are insurance companies, either subsidiaries of banking groups (CEGC belongs to BPCE, Camca to Crédit Agricole, CMH to Crédit Mutuel), or independent (CNP Caution, Axa, several mutual companies…).

Outstanding loan amount covered (2019)	
Crédit Logement	€375bn
CEGC	€188bn
CAMCA	€123bn

Market leaders

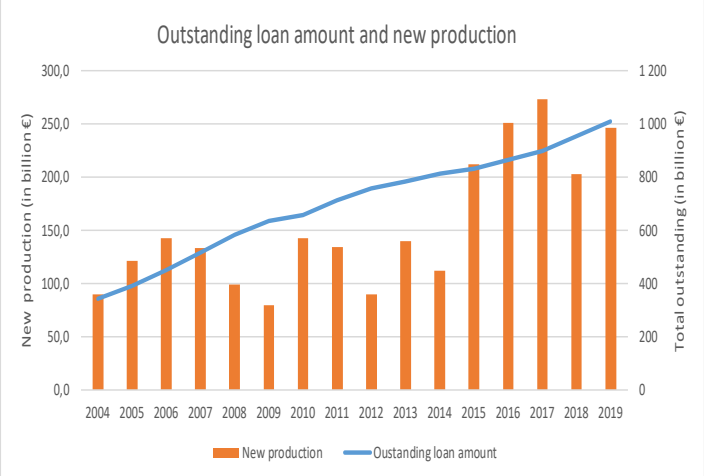
Source: 2019 annual reports

3. BNP Paribas, Crédit Agricole, LCL, Société Générale, Crédit Mutuel, BPCE, La Banque Postale, HSBC France

SOME FIGURES ON FRENCH HOME LOANS

The outstanding loan amount in France has steadily increased over the past to reach EUR1,000bn in 2019. As to the production of new home loans it fluctuates depending on the underlying economic environment. The period 2008-2009 corresponds to the years where the production has been at its lowest.

In France 58% of the households own their residential property. One third of them are still paying back their loans[4]. Unlike some other countries where tax rules might foster "in fine" loans (the capital is paid back at maturity, only the interests are due periodically), the major part of home loans in France are amortizable (the regular instalments account for the payback of the loan in addition to the payment of the interests on the outstanding capital), which means that the borrower's debt to the bank decreases over time. A specificity of the French home loan market is that borrowers almost always request a fixed interest rate. This can be explained by the low rates currently and maybe the traditional aversion of French borrowers to interest rate risk. This ensures the instalments paid by the borrower remain the same over the whole duration of the loan.



Source: Banque de France

DEFINITION :

- The "Loan To Value" (LTV) is the ratio of the borrowed amount to the value of the purchased property. The lower this ratio (or the higher the initial capital contribution), the less risky the loan since the sale of the property should offset any loss due to a default.
- The "Loan To Income" (LTI) is the ratio of the borrowed amount to the yearly disposable income of the borrower
- The "Debt To Income" (DTI) is the ratio of the debt expense to the disposable income.

In France, around a third of the income is devoted to the home loan instalments. This is regarded as rather high in recent history, hence the warning sent by HCSF in 2019[5].

France	
Maturity	19.9 years
Avg. Loan Amount	170,187€
LTV	87.3%
LTI	5.2
DTI	30.1%

Key metrics on French home loans issued in 2018 (metrics at inception)

Source: Publication ACPR, Le financement de l'habitat en 2018

Country	Share
France	98.5%
Germany	88.3%
Italy	66.7%

Share of Home Loans issued at a fixed rate

Source: ACPR and European Mortgage Federation, 2018

The LTV is quite high in France but it should not be used as the only indicator to assess the riskiness of a loan, all the more so as the mortgage is not the preferred option in France to secure a loan. Besides, the LTV decreases over the term of the loan when they are amortizable. The LTI and DTI are there to complete the assessment. It seems intuitive that portfolio metrics such as LTI or LTV exhibit a positive correlation with default rates. A study from ECB[6] based on European residential real estate loan concluded that for an average borrower a 10 percentage point higher LTV at origination leads to an increases of the default probability by 0,2 percentage points and a higher LTI by 1 leads to an increase of the risk of defaulting by 0,1% percentage points. It is also interesting to note that loans for the purpose of renovation seem to default more than those for house purchase. The observed default rate for France in the data set analyzed by the ECB is 1,5% while it is 6,2% for the total sample.

In addition to the aforementioned indicators the institution delivering home loan guarantees also takes into account the total borrowed amount, the maturity, the number of persons in the households, and the remaining savings and wealth that have not been engaged to finance the property, among the meaningful variables to assess the credit worthiness of a borrower.

4. Figures from Insee, as at 01/01/2017 .
5. see §II.A.1
6. The impact of lending standards on default rates of residential real estates loans, Occasional Paper Series No 220 / March 2019

III. THE REGULATORY RISK CAPITAL MODELS

French home loan guarantees can be delivered by insurance companies and credit institutions. These undertakings are subject to financial regulation, Solvency II (for insurers) or Basel III (for banks), which require they hold sufficient capital. Both regulatory models are based on risk, yet they result in significant differences. Also both regulations recognize the benefit of (re)insurance, that plays the part of a capital management tool.

A. THE SOLVENCY II STANDARD FORMULA FOR CAUTION

Insurance companies face inversion of the production cycle: unlike other industries, the cost for providing the service is unknown to the insurance company when they sell the contract. The premium might not be sufficient to face future unknown claims, and basically that's why these companies follow specific regulation: they need to hold sufficient capital to face this volatility, to make sure they will fulfil all their contractual obligations towards policyholders, hence supporting the general economy, whatever the circumstances.

In Europe, as stated by the Solvency II regulatory framework, this capital buffer must be sufficient to cover the worst-case scenario an insurance company might face with a confidence level of 99.5% over 1 year.
Like most capital regulations, Solvency II is a risk-based regime, which means that the required capital amount (Solvency Capital Requirement - SCR) will indeed be specific to each company based on their very own risk-profile (e.g. underwriting policy and asset allocation policy). While some insurance companies with extensive modelling capacities can opt for a comprehensive "internal model" of their risk, most companies use the "Solvency II standard formula", in which most calibration has been done by EIOPA on European market data.

1. Capital requirement for underwriting caution

For Solvency II, the caution guarantees are classified in the line of business "Credit and Surety insurance". The SCR for underwriting this risk includes the following components:

- The Premium risk

Refers to the potential under-estimation of the future claims. The SCR is based on the net premium volume, multiplied by three[7] times the regulatory coefficient.
This coefficient captures the volatility of the loss ratio as measured on European historical data for the Credit and Surety line of business. The considered premium is the annually earned premium, with some consideration for the unearned premium that can be material for caution contracts.

- The Reserve risk

Refers to potential mis-reserving of the claims which are already incurred. The SCR is based on the best estimate of claims volume, multiplied three times by the regulatory coefficient reflecting the volatility of the line of business for the reserving risk.
For insurers which subrogate the banks in the recovery process, cashflow dynamic of caution business account for a negative net best estimate of claims, hence a nil reserving risk. Indeed, claims are usually settled quickly after the notification, so hardly any reserve for outstanding claims, but recoveries are significant and can spread over a long time.

	SCR	σ (2016-2019)	σ (2020)	V
Premium risk	3 σ V	12%	19%	Annual net premium + Future premium
Reserving risk	3 σ V	19%	17.2%	Net reserves

Source: article 116 and followings and Annex II of the 2015/35 commission delegated regulation (EU), including amendment of March 2019 ("Solvency II delegated act")

7. Three standard deviations being close to the 99.5% quantile of a log-normal distribution

• The CAT risk

Whereas the premium risk reflects the attritional risk, the companies also must consider uncertain events with low frequency and high severity, differentiated between natural catastrophes (e.g. windstorm, flood, etc.) and man-made catastrophes (e.g. explosion to industrial plants, planes crashing, etc.).

For credit risk, two catastrophe events are considered, namely an "exceptional default" of the two largest exposures and a "recession" event where loss equals one year of earned premium. For the caution risk, without significant concentration of counterparties, the first one is not material.

Because all the aforementioned risks (stress of attritional loss ratio, stress on claim reserves development, CAT event, each being calibrated so as to represent the 1-in-200 year worst case) are not fully correlated, a diversification benefit is recognized among them.

2. Capital requirement for other risks

Before being released for claims settlement, paid premiums accumulating on the insurer's balance sheet are invested in financial assets (equities, bonds, real estate, or cash) that might be exposed to a market risk. Likewise, debtors such as reinsurers are exposed to default risk. Finally, like any company, insurers face operational risk. These three risks are taken into account by the standard formula and increase the solvency capital requirement.

Conversely, loss absorbing capacity of deferred tax or of technical provisions (when profit-sharing mechanisms) can reduce the SCR.

B. COMPARISON WITH THE CRD IV – BASEL III STANDARD APPROACH

Capital regulations for insurers and banks work hand in hand. In Europe, credit institutions comply with the so called "CRD IV / CRR" framework, based on the core principles known as Basel III. In a nutshell, banks shall calculate their capital ratio as the "regulatory capital" over the "risk-weighted assets" (RWA) and this capital ratio cannot be lower than 8%, the "Cooke Ratio".

- RWA is calculated by multiplying the exposures by regulatory coefficients reflecting their risk-level, either calculated by an internal model (internal ratings-based approach - IRB, either foundation or advanced) or by a regulatory standardized approach. For the caution business, the asset is the outstanding loan, and the risk-weighting factor is 35% when secured by a mortgage on residential property[8]. Further discrimination between risks has been suggested for the coming Basel IV regulation which will succeed Basel III, with coefficients ranging from 20% to 70% depending on the loan-to-value of the mortgage.

The two considered regulations differ in their choice of the proxy for the volatility (earned premium vs. residual exposure), in their protection level (99.5% over 1 year *vs.* historical empirical 8%) and some operational differences (considered risks, calibration process, diversification benefit, etc.).

Illustrative case:

To buy a house an individual borrows EUR 100 000 from a bank.

- For a 10-year amortized loan with 2% annual interest, they pay back EUR 920 per month (EUR 11 042 per year)
- The future Basel coefficient for this LTV is assumed to be 25%
- Caution insurance premium rate is 1% (EUR 1 000), paid upfront
- The outstanding loan value decreases from 100 000 to 0 over the 10-year amortization period
- Earned premium are ca. EUR 100 per year

8. Comprehensive regulation: see articles 125 and following of the consolidated 575/2013 European regulation ("CRR")

<table>
<tr><th>Solvency II SCR</th><th>Basel III</th></tr>
<tr><th colspan="2">Risk basis (all values in EUR)</th></tr>
<tr><td>• Earned premium = 100 per year
• Future premium is 900 at the begenning of the first year, 800 for the second year, etc.</td><td>• Exposure = 100 000, secured
• Reduces over time (91 000 after 1y, 82 000 after 2 years, …)</td></tr>
<tr><th colspan="2">Standard formula (all values in EUR, some assumptions apply)</th></tr>
<tr><td>• Premium risk = 3 x 19% x 1000 = 570
• Reserve risk = 0
• CAT risk = 100% x 100 = 100
• Non-life diversification = -67
• Total SCR_{NL} [9]=603</td><td>Credit risk = 8% x 25% of residual exp = 2 000</td></tr>
<tr><th colspan="2">Required financial resources (all values in EUR, some assumptions apply)</th></tr>
<tr><td>For insurance companies, SCR is the value-at-risk. Required financial resources also include the best estimate of liabilities, assumed here at 70% combined ratio.

<table><tr><td>Beginning of year</td><td>1</td><td>2</td><td>3</td><td></td><td>9</td><td>10</td></tr><tr><td>SCR</td><td>603</td><td>547</td><td>491</td><td></td><td>169</td><td>127</td></tr><tr><td>BEL[10]</td><td>700</td><td>630</td><td>560</td><td></td><td>140</td><td>70</td></tr><tr><td>Total</td><td>1303</td><td>1117</td><td>1051</td><td></td><td>309</td><td>197</td></tr></table></td><td>Before IFRS9, banks do not reserve based on statistical default, and asset value is not impaired before actual default.

<table><tr><td>Beginning of year</td><td>1</td><td>2</td><td>3</td><td></td><td>9</td><td>10</td></tr><tr><td>RWA·8%</td><td>2000</td><td>1819</td><td>1634</td><td></td><td>404</td><td>220</td></tr></table></td></tr>
<tr><td colspan="2">To carry such a risk, at inception date, Solvency II requires an institution to hold at least EUR 1 303 of assets, to cover both the liabilities and the capital requirement, whereas Basel requires them to hold at least EUR 2 000.</td></tr>
</table>

C. ADVANCED INTERNAL MODELLING

Regulatory models often result from a compromise between several objectives, namely sound risk management, setting an international level playing field and operational implementation at a reasonable cost. They are not perfect, and one shoe does not fit all. Companies can be willing to capture their specific risk by more advanced modelling.

For caution risk, own-risk assessment (ORSA process for insurances, ICAAP for banks) implies developing a longer-term view to apprehend market cycles, taking into account relevant economic factors, taking into account the French market specificities and assessing the consequences of severe events (e.g. massive fraud by a property developer, economic recession after a pandemic for caution business). In some cases, national supervisors can recognize the validity of the company's internal model and approve its regulatory usage to assess the regulatory capital instead of the standard formula.

ORSA process or internal model can lead to a need for capital exceeding the standard formula's requirement.

D. RISK-MITIGATION VIA (RE)INSURANCE

(Re)insurance markets are well known for efficiently transferring risks. They can also benefit credit institutions. The risk mitigation they provide is recognized by most capital models, especially when risk-based. Reinsurance has become a capital management tool. When ceding risks on the reinsurance market, a regulated company retains less risk, hence a drop of their capital requirement that is an efficient alternative to capital injection or subordinated debt financing. Furthermore, capital optimization opportunities can arise, leading to a win-win situation. Indeed, carrying a risk on a large, accurately modelled and well diversified balance sheet usually provides a significant capital benefit.

9. SCR_{NL} refers to the capital requirement for the premium and reserve risk only, assuming only Credit & Surety business is written. Solvency II also considers other risks (market, default of the counterparties, operational) that are not specific to Credit & Surety business
10. Best Estimate of Liabilities

1. The benefit of proportional reinsurance is well recognized

In Solvency II, like most capital models, the benefit of proportional reinsurance is well recognized, the calculation of the underwriting risks being based on net volumes.
When ceding let's say 30% of the premium in a traditional quota-share reinsurance treaty, the net loss in case of mispricing is actually reduced by 30%, so is the net loss in case of a catastrophic event. As a consequence the capital requirement is reduced by 30%. Likewise, a cession of 50% of reserves via a proportional retrospective treaty reduces the net loss by half in case of adverse development of past claims, that is reflected by a reduction of 50% of the reserve risk (this is not relevant for caution insurers with negative best estimate of reserves as shown earlier).

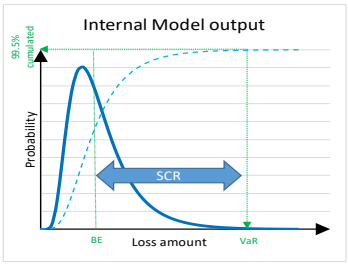
For the most advanced models (Solvency II, AM Best, K-ICS …) further benefit can be recognized when efficiently managing the cession rate for each line of business, so as to optimize the diversification benefit.

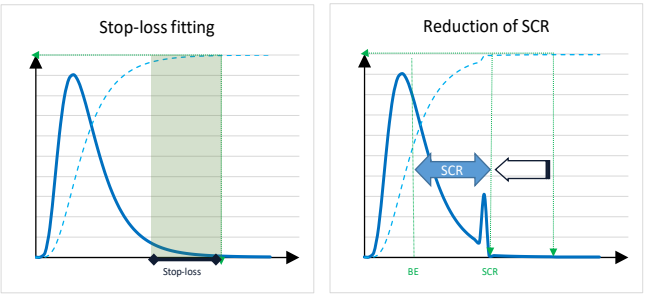
The increase in credit risk due to counterparty risk on the reinsurer is usually not material for a well-rated reinsurer. But it can be an issue with riskier counterparties.
This type of reinsurance is also recognized as guarantee acting as a credit risk mitigation technique[11] for banks.

2. The benefit of non-proportional reinsurance is recognized in advanced models

When it comes to non-proportional reinsurance, there is no reliable way to measure their actual protection based solely on the premium and reserve amounts, further analysis of the contractual conditions would be required (relative positioning of the transferred layer, reinstatement and aggregate features etc.). Therefore, most regulations do not fully recognize their benefit unless advanced modelling is performed by the company.

When they use an internal model (or ORSA model) that properly captures the risk transfer, a regulated undertaking can benefit from a wide scope of risk mitigation techniques, including non-proportional structured reinsurance that efficiently fits on the outputs of their risk model.

<table>
<tr>
<td>• A financial company is able to model the risk on a portfolio.
• They are submitted to a capital requirement based on VaR.</td>
<td> 
</td>
</tr>
<tr>
<td>Reinsurance stop-loss

• Calibrated on the internal model output
• Reduces the net loss
• High attachment point for minimal cost</td>
<td> 
</td>
</tr>
</table>

Case study: Alternative reinsurance for advanced capital models

11. See chapter 4 of title 2 of part 3 of the "CRR"

IV. MODELLING THE RISK: ACTUARIAL AND ECONOMIC ANALYSIS

A. CREDIT RISK: WHAT ARE THE RISK FACTORS?

French home loan guarantee insurance covers the risk of borrowers not being able to pay instalments according to schedule. We will call this the default risk. Additionally, the insurer bears the risk that recoveries from foreclosure are not enough to cover the outstanding loan, in case of a default. We will call this the recovery risk. Additionally, the recovery risk entails the risk that the recovery process takes longer than expected.

Credit risk is the consequence of both default and recovery risk. The usual mathematical description of credit risk is made via the PD (Probability of Default) and the LGD (Loss Given Default); for an individual risk, the expected loss (EL) would then be:

$$EL = PD \times LGD.$$

The default risk is mostly driven by a reduced available household income, while the recovery risk is driven by the development of house prices. Below we outline several factors that can lead to an increased credit risk. Some factors will lead to rather gradual changes, while others arise as a shock.

These factors will likely not act in isolation but rather reinforce each other and have an impact on both default and recovery risk, either by changing the risk on an issued loan or by changing the conditions of new loans[12].

Economic Factors	Shocks	Others
• Unemployment Rate • GDP • Interest Rate • Household Financial Fragility • Credit Growth • Indebtedness • Housing affordability • Bank capital position • Inflation / Deflation	• Financial/ Economic Crisis • Pandemic • Political Disruptions • Nuclear Catastrophe • Civil unrests • War	• Divorce Rates • Demography • Lifestyle / Technology (e.g. teleworking) • Governmental housing policies • Credit market regulations • Property Market Regulation • Financial Literacy

As outlined in chapter II.A, there are several important risk mitigants such as the borrower insurance, underwriting focus on the affordability of the loan and far reaching recovery rights for the insurer.

Moreover, at macro-economic level, the French environment is quite protective for the borrowers and the caution insurers, with a large covered base limiting risk related to anti-selection effects and borrower insurance. Moreover, for the sake of social wellbeing and financial stability, it is likely the government and regulators would take actions to counteract adverse developments.

The consequences of a crisis will also depend on individual portfolio characteristics. Important factors are the regional distributions, type of building, maturity of the portfolio, distribution of occupations, marital status of insured, loan purpose (renovation, purchase or construction) and portfolio metrics such as LTV, LTI, or DTI, as defined in a dedicated section.

12. See also Canepa and Khaled (2018)

The Apollonia scandal

The Apollonia scandal is deemed to be France's biggest real estate and finance scam, that accounts for hundreds of claims to caution insurance.
Apollonia was a French property development company that sold several thousand housing units to private individuals in the 1990s and 2000s years. The housing units were sold within a program that gave investors tax advantages.
During the investment process the private investors were misguided and this has led them into buying new properties meant to generate a rent income in areas where there has been no demand for rental housing, which again resulted in over indebtedness.

In 2008 the Marseille Regional court opened a judicial investigation concerning the charges of organized fraud, the use of forged documents, and the unlawful exercise of the activity of intermediary in banking operations.

While all the court trials are still not finished today, people from different organization have been indicted including employees from different banks, public notaries, and managers from Apollonia.

B. FRENCH HOME LOAN REINSURANCE CONTRACTS AND ITS MODELLING

An appropriate model for this risk must include the consideration of extreme scenarios such as the Apollonia scandal or the 2008 financial crisis. While there are risks that can be modelled relatively precisely, as there is plenty of loss experience, other risks are much harder to quantify, and French home loan business is surely one of them due to limited adverse experience and the complex nature of the risk.
To cope with this uncertainty, the reinsurer can only allocate a "risk capacity" to these types of risk.
A model can assist here to estimate a technical price but also to make an efficient allocation of reinsurance capacity. In the following we briefly describe the model used by SCOR to model French home loan contracts. But first we want to give a brief outline of the mechanics of a typical French home loan reinsurance contract.

A typical cover for this segment is a multiyear stop loss which is structured such that the insured can obtain protection during a severe crisis.
The reinsurer typically pays all losses in scope of the contract in excess of a pre-agreed priority. The losses in scope are usually defaults occurring for example during the next five years, while it is contractually defined from which UWYs (underwriting year) these defaults can originate. Recoveries are collected to the benefit of the contract until ultimate.

In the figure bellow, we display an example, where a surety company has written business let's say since 2013 and the reinsurance contract commences in let's say UWY2020. The defaults in scope (green area) are all defaults in the next five years from all past and current UWYs.
The grey area represents defaults that occur five years after inception of the reinsurance contract. These defaults are not covered by the reinsurer anymore and are retained by the insurance company.

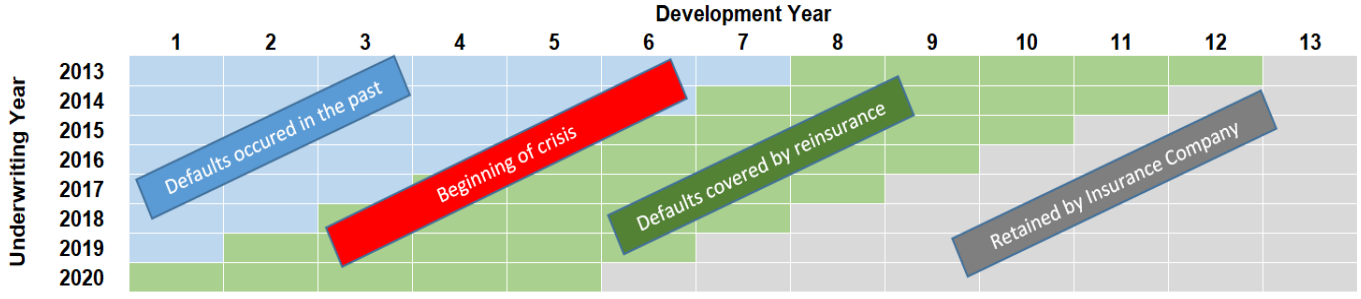


Illustration of coverage

Before discussing the mechanics of the model in more detail, we want to briefly outline aspects that a model should cover and how we approached it.

Characteristics of the Risk	How is this reflected by the model?
The amount of reinsured losses depends not only on the magnitude of the crisis but also on the duration of the crisis and the contractual coverage period.	The model applies default pattern to each UWY to cover the contractual coverage period.
Insurance companies with a mature portfolio are less exposed to a crisis as opposed to a company that has recently started business, as loans from a mature company have been paid back in average to a higher extent.	Therefore, it is important to model each UWY separately and the amount of outstanding loan per UWY must be considered.
The amount of defaults in a crisis also depends on the quality of the loans written in each UWY.	We assume that the quality of the portfolio is reflected by a projection to ultimate of default rate per UWY.
Default risk and recovery risk are negatively correlated in extreme scenarios.	The model considers a negative correlation of default rates and recovery rates.

As made explicit in the table above, our modelling approach focuses on the characteristics of a subject portfolio.
Economic variables are considered in a more qualitative basis when the underwriting decision is made.

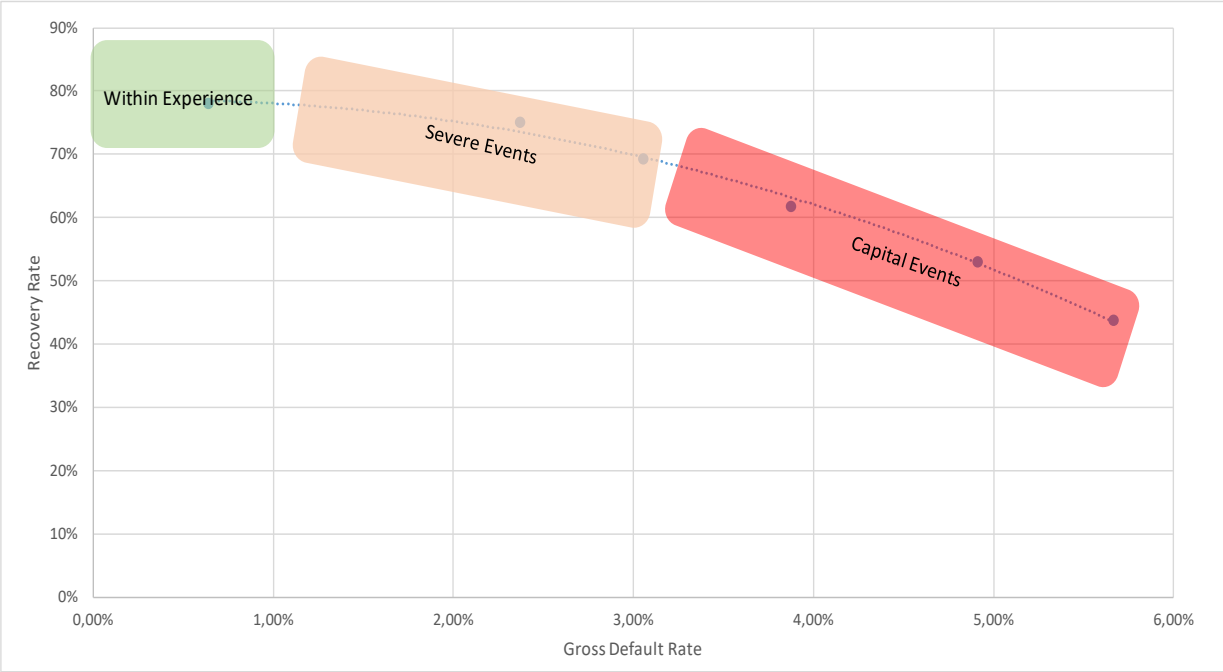
The table below illustrates the model mechanics with a simple example. For this example, we assume an insurance company in business since 2013 and writing each year EUR 1 000 of loans. Each column is explained in detail in the next table.

Underwritting Year	(1) Loan Amount Written	(2) Outstanding Loan Amount	(3) Ultimate Default Projection	(4) Shock Rate	(5) Ultimate Default Rate	(6) Payment in next 5 years	(7) Loss to contract per UWY
2013	1000	650	0.54%	2.50%	1.81%	28%	5.08
2014	1000	700	0.48%	2.50%	1.89%	32%	5.97
2015	1000	750	0.35%	2.50%	1.96%	39%	7.60
2016	1000	800	0.31%	2.50%	2.06%	46%	9.55
2017	1000	850	0.31%	2.50%	2.17%	51%	11.00
2018	1000	900	0.32%	2.50%	2.28%	58%	13.18
2019	1000	950	0.40%	2.50%	2.40%	63%	15.11
2020	1000	1000	0.68%	2.50%	2.50%	58%	14.60

Item No	Description
(1)	Loan Amount Written per UWY
(2)	Outstanding Loan Amount per UWY (loans that have not been paid back). For simplicity we assume that 50 is paid back each year and each UWY.
(3)	Ultimate Projection of the default rate per UWY using a standard chain ladder method. This represents the forecast for each UWY without giving allowance to a crisis.
(4)	The shock rate is a random variable. Its distribution is derived from a distribution fit to historical data. The shock rate for every UWY is the same since a shock has an impact on the loans from all UWYs. However, the impact of the shock varies in each UWY depending on the portfolio maturity, see (5). In this example, we assume a shock rate of 2,5%.
(5)	The Ultimate weighted default rate is the ultimate default rate in a shock scenario. It is calculated as (2)/(1) x (4) + ((1)-(2))/(1) x (3). In doing so we give some allowance to the maturity of the UWY and the quality of the portfolio written in each UWY.
(6)	This describes the expected payments (defaults) in the next five year in terms of the ultimate expected loss ((1)x(5))
(7)	Loss to contract per UWY is the loss that eventually will be ceded to the reinsurance contract: (1)x(5)x(6). The sum of losses of column (7) is then relevant to the reinsurance contract (before recoveries).

Ultimately, recoveries still need to be deducted from the losses in column (7). The recoveries depend on the severity of the shock rate and the maturity of the portfolio.

In the graph below, the relationship between Recovery Rates and the Shock Rate is illustrated. Everything except the green box is basically beyond the experience and therefore based on extrapolation and assumptions.



Source: SCOR

C. PRICING CONSTITUENTS BEYOND THE LOSS MODEL

Firstly, the loss model as described gives an expected loss for each contract, that looks usually quite low compared to the high contractual limits. Yet the mean is not the best performance indicator, that is why the model also provides the distribution of the Net Present Value (NPV), the discounted result, i.e. premium minus claims minus expenses, of the contract after allocation of internal expenses, from which one can read off the volatility of the contract. The higher the volatility of the NPV (the heavier the tail of the distribution), the higher is the uncertainty for the reinsurer and the higher is the required amount of capital for the reinsurer.

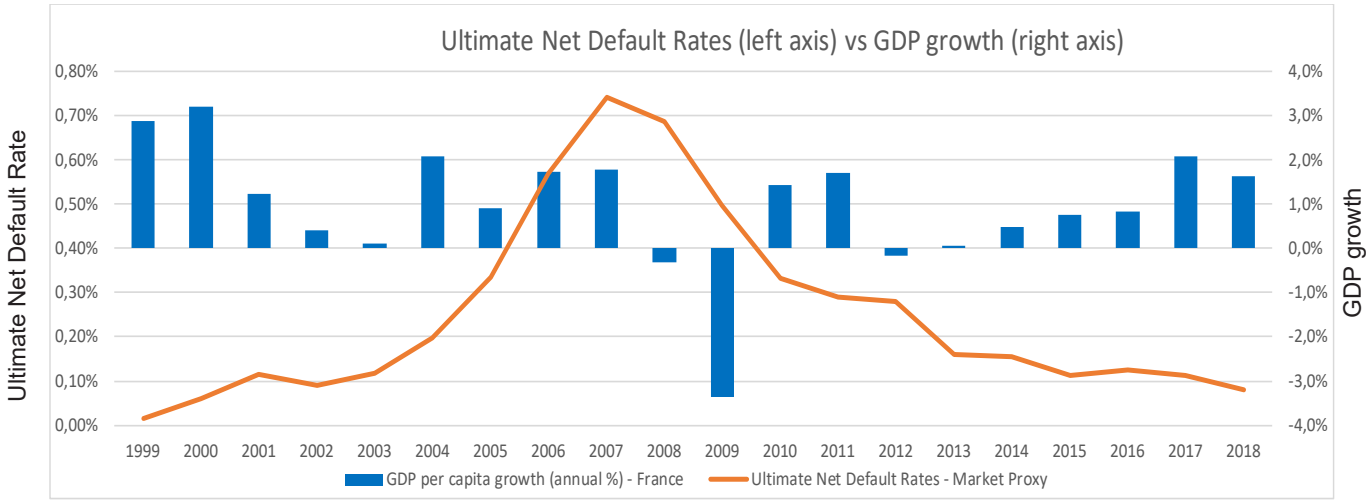
The volatility or downside of a contract is usually evaluated by metrics such as Value at Risk (VaR) or Tail Value at Risk (TVaR). For reinsurance covers with high attachment points, the ceded risk is remote, leading to a high VaR or TVaR. As a consequence, the contribution to the reinsurer's group capital is high and the cost of capital becomes a significant component of the reinsurance premium.

D. CASE STUDY: SENSITIVITY OF THE DEFAULT RATE TO GDP

In the following we want to investigate sensitivities of default rates in respect of GDP and outline further reasons for the elevated default rates around the financial crisis.

The debtors' ability to pay their instalments is mainly determined by their available income. For the sake of simplicity, we consider GDP as an indicator for the state of the economy. The next chart highlights the correlation between this indicator and the risk.

The default rates for this analysis consider all loan insurances that were written during the respective underwriting year, regardless of their maturity at default date. They are considered net of recoveries. It is important to have in mind that defaults more likely occur 3 to 7 years after inception (underwriting year), yet up to 20% of the defaults occur after the 10th year of the loan.



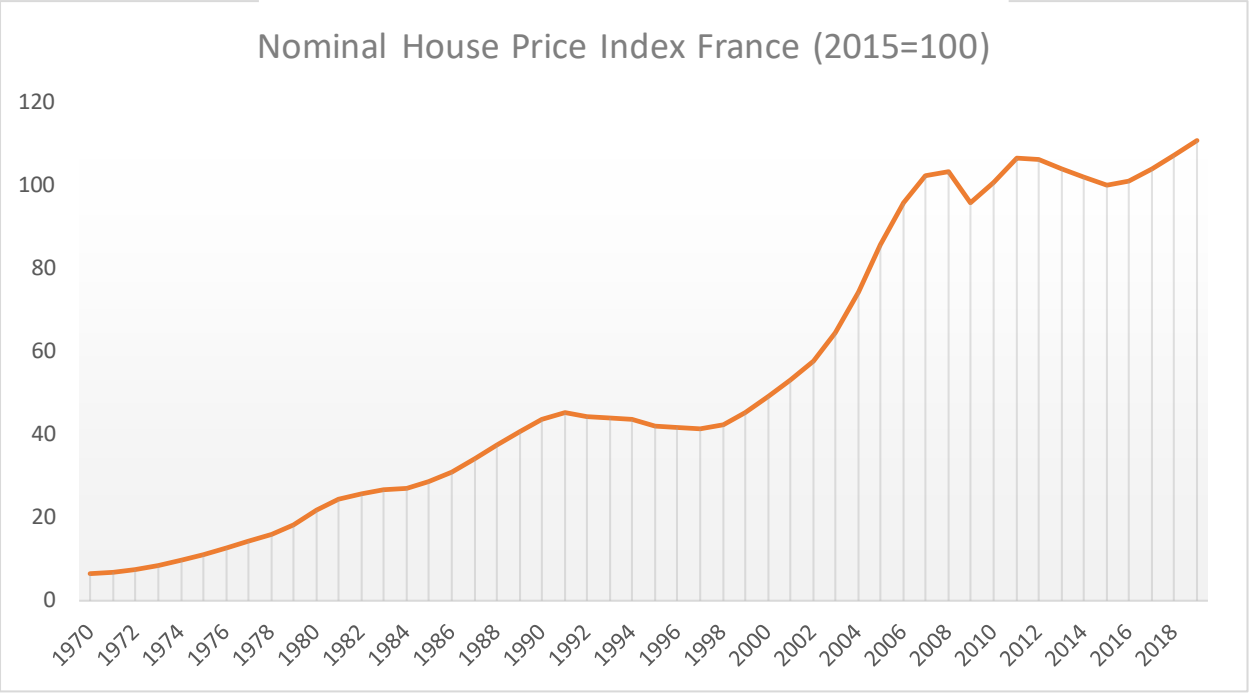
Ultimate Net Default Rates *vs* GDP growth

World Bank. SCOR

At first sight the development of GDP and net default rates seems surprising during the financial crisis as default rates are increasing already before the financial crisis and decrease when the financial crisis was at its peak during 2008 and 2009.
There are three reason for this:

- Firstly, the Apollonia scandal has an impact on the default rates and, during the years prior to the financial crisis, underwriting policy of surety insurer may have been less strict.
- Secondly, as described above, the default rates for example of 2009 only consider loan insurance that have been written during 2009. But in 2009 insurers have already adjusted their underwriting policy and acting more cautious now in the presence of the crisis.
- Thirdly, the reason that UWYs before the financial crisis are affected at all is that, defaults occur during the entire duration of a loan. Hence events that occur after an underwriting year can have an impact on previous underwriting years.

It took less than two years for house prices to recover from the large dip they suffered during the 2009 financial crisis. This has helped surety insurers with good recoveries, compared to a scenario of a lower house price environment sustained over a longer period. In addition to lower recoveries, insurers may potentially face also a liquidity issue as they may delay the foreclosure of estates (because house prices dipped) while banks have to be reimbursed immediately.



Nominal House Price Index France (index 100 in 2015)

Source: OECD

V. CONCLUSION

At SCOR we have been working alongside the “caution” carriers since 2015, increasing our knowledge and expertise over time.
This experience, more generally combined with state-of-the-art modelling know-how, which is a corner stone of our Solvency II Group Internal Model, led us to develop a reliable approach to assess the tail risk. This approach allows us to provide our clients today with significant reinsurance capacity.

Then the efficiency of reinsurance explains the attractiveness of this solution for the issuers.
Transferring risks on a reinsurer’s balance sheet, and in particular on the SCOR’s balance sheet, opens access to a capital source that turns out to be competitive against other capital sources.
Competitiveness of reinsurance capital is actually possible through wider mutualization and significant diversification between risks.

Availability and efficient usage of reinsurance capacities are key to support the competitiveness of the home loan guarantee, making it affordable to the households. And maybe, a future of the “caution” product could be foreseen beyond the French market?

Michael WOBST
Pricing Actuary - Alternative Reinsurance Solutions
Actuarial Pricing - SCOR P&C
mwobst@scor.com

Michael Wobst graduated from Technical University of Munich with a degree in financial mathematics and economics.
He started his career with a management trainee program at W&W, a German insurance and banking company. Thereafter, he moved to SCOR in Cologne where he was in charge of treaty pricing for several years. Since 2017, he supports the Alternative Solutions unit of the company. Michael Wobst is a certified actuary (DAV).

Kevin ZIEGELMEYER
Marketing and Modelling Actuary
Alternative Solutions - SCOR P&C
kziegelmeyer@scor.com

Kevin joined SCOR in 2019 as a marketing and modelling actuary in the Alternative Solutions team where he supports underwriters in designing and modelling tailor-made structured reinsurance solutions. He also contributes to technical studies on cedents and on the insurance market with a focus on Solvency 2.

Prior to joining SCOR, Kevin has worked 3 years in Switzerland, at PwC Actuarial Services first, and then at Zurich Insurance Company as a cash-flow modeller.
Kevin holds a Master's Degree from Ensae Paris (2015, major: Economics and Statistics) and is a member of the French Institute of Actuaries.

For more information, please contact our Alternative Solutions team:

Eric LE MERCIER
Chief Underwriting Officer
elemercier@scor.com

Reinsurance

Brice DEPLANTE
Deputy Chief Underwriting Officer
bdeplante@scor.com

Julien GALZY
Senior Treaty Underwriter - APAC
jgalzy@scor.com

Thomas RENGGLI
Senior Underwriter - DACH, NCEE, ME & Africa and Lloyd's Capital
trenggli@scor.com

Leonid ROUSNIAK
Junior Underwriter - Western - Southern Europe
lrousniak@scor.com

Stève UDRIOT
Senior Underwriter - Parametrics & Specialty including Home Loan Guarantee
sudriot@scor.com

Specialty Insurance

Mathieu PASQUAL
Deputy Chief Underwriting Officer
mpasqual@scor.com

James DONALD
Speciality Manager captive - London market & Europe
jdonald@scor.com

Lawrence MARCUS
Senior Underwriter - Americas & Parametrics
lmarcus@scor.com

Advisory and technical functions

Eike MEERBACH
Pricing Manager
emeerbach@scor.com

Jacky MOCHEL
Chief Technical Officer
jmochel@scor.com

SCOR SE
5, avenue Kléber -75795 Paris Cedex 16
France
scorglobalpc@scor.com

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