We define risk as the uncertainty of the future outcome of a current decision or situation. Insurance provides a way of alleviating this risk. To give an intuitive feeling of insurance and the risk involved, we shall present a simple example. Let us assume that a customer contacts an insurance company with the following problem: he must pay €10 every time a dice displays the number six, otherwise he pays nothing. Moreover, the dice is thrown six times. He would like to insure the risk, so the insurer is confronted with the problem of giving the customer a price for this risk.

Before we move to compute a price, let us first try to understand the risk. If the customer has extremely bad luck, he will have to pay €60. This is his maximum “exposure”. If he is lucky, he will pay nothing. Those are the most extreme outcomes of his risk. The probability of getting a six on a dice is one in six, so the expected loss (the average outcome) on this risk is 10 (the amount we have to pay) times six (the number of draws) times 1/6 (the probability of getting a six), which, in this case, is €10.
Now let us think about the insurer: if he prices the risk at € 60 plus costs, he has no risk, but the customer will probably not buy the contract because in reality he obtains nothing (and actually loses because of the costs). If the insurer prices the risk at the expected loss (€ 10) plus costs, he still runs the risk of losing more in one out of three cases (deduced from integrating the probability distribution). To make sure that he can pay his liability in any case, he needs a remaining capital of € 50.

At this point, we see the role of capital for an insurance company: it ensures that the company can pay its liability even in the worst case. In a real insurance situation, the capital will only cover the risk up to a certain, very low probability: 1% or 0.4%. The management of the company usually determines the level of risk it is willing to accept. In our example, a level of 0.4% means that the insurance company would have to put up capital for covering up to three losses that would be € 20 on top of the expected € 10. That is the risk-based capital (RBC) in this simple example.

Hence, we have the probability distribution of all the outcomes. In jargon this is called “loss distribution”. It is the basis for building a pricing model.

### Role and Cost of Capital

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For insuring a sustainable business, the insurer needs to pay back its shareholders for the capital they provided and make sure that its expenses are covered. Let us assume that the insurer’s costs are 0.5 and its cost of capital before taxes\(^1\) is 15% (0.15*20=3). The insurer therefore needs to add a “risk loading” to its premium to pay for the cost of the risk capital he has to put up for this transaction. As already mentioned, this risk loading should be neither too big – otherwise the customer will not buy the insurance – nor too small – otherwise the insurer cannot pay back its shareholders and runs the risk of being short on capital.

\(^1\) A capital cost of 15% before taxes is reasonable because the investor will demand a risk premium for this business making the price higher than the risk-free rate, and taxes will take up to one third of the profits.

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**Figure 2 - Example of premium components and their origin**

<table>
<thead>
<tr>
<th>Company Structure and Capital</th>
<th>Premium</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost of capital</td>
<td>Expenses</td>
</tr>
<tr>
<td>Value-at-Risk</td>
<td>Risk Loading 0.15*(30-10)</td>
</tr>
<tr>
<td>Loss Model</td>
<td>Expected Loss</td>
</tr>
<tr>
<td>Mean</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td></td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td>13.5</td>
</tr>
</tbody>
</table>
Insurance Premium as the “Price of Risk”

The premium we have computed here comprises the expected loss + costs + the risk loading. The insurer will ask for a premium of $10 + 0.5 + 3 = €13.5. If the customer buys the insurance policy, he will obtain “capital relief” since he does not have to put any money aside for covering the risk. At its highest, his capital relief would be €50, but he would generally compute his risk-based capital the same way as the insurer; we could assume that he receives capital relief of 20. Because of capital costs, the customer might be willing to buy the contract in order to obtain this relief.

The insurer has received €10 (plus 0.5 for covering the costs), put up capital of 20 to cover his liability, and got three to pay back to his shareholders. If the outcome of the contract is as expected, setting aside the investment income to be made on the received premium, he would make a profit of 3 or a 15% return on capital (since 20 had to be put up as capital and 3 were earned in the transaction). This is risk-based pricing of an insurance contract.

The more transactions of this kind the insurer makes, the fewer chances there are that he will have to pay the full amount of the exposure (n times 60), and the more certain he will be to pay the expected loss because of the law of large numbers.

Increasing Risk Implies Higher Premium for the Same Expected Loss

To illustrate the influence of risk on price, let us now assume that the client is exposed to a slightly different example than before. Now he is exposed to only one throw of the dice, but if a six is displayed, he has to pay €60. In this case the expected outcome is still 10 (60 times 1/6) but the risk is to pay 50 more (60 minus the expected loss). Thus the insurer would have to put up capital of 50 (at the same 1% threshold) and would therefore ask a price of $10 + 0.5 + 7.5 = €18. This example shows that even if you have a risk that has the same expected payment, its price can be much higher if the exposure is higher. This second example illustrates the fact that increasing the limit on a deal, even if the expected claim stays the same, has a cost, which in this case is 18 − 13.5 = €4.5, representing a price increase of one third. This is due to the increased risk of the whole deal and thus a higher RBC.

Diversification Benefit and Reinsurer Role

With these simple examples, we see the role of capital for an insurance company and the mechanism of pricing risk. In practice, of course, risk cannot be modelled as easily as with the roll of a dice. One needs to use an actuarial model to determine risk. Yet our example is not that far from reality. If we used the example of a credit & surety insurance company that holds a portfolio of six bonds, each with a default probability of 1/6, we would come very close to it. We also see here that diversification is much more beneficial than increasing exposure on one bond.

A reinsurance company, on the other hand, has a very diversified portfolio that allows it to reduce the risk of a single transaction. If we run the example above in our own pricing tool, we would come up with a price of €11.5 for the first example, with costs that are about the same (0.5). For the second example, we would come up with a price of €12.5. In the latter, the risk loading has doubled. The difference in price is due to the fact that the value of this risk does not only depend on the risk itself, but also on the portfolio of the company (i.e. the other risks in the book), which is very diversified. Thus the relative price of the risk (relative to our portfolio) is much lower, because the additional risk is diversified away in our portfolio. This is the main advantage of reinsurance.

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