The implementation of the disclosure regulation on the risk-profile of non-equity investment products should allow the investor, even assisted by a financial advisor, to choose the financial product more suitable to his investment objectives.
The information to be provided to the investor, in a simple, clear and fair way, must allow an assessment of his needs in terms of:

**Time goal: liquidity/investment horizon**

**INVESTMENT HORIZON**

**Risk profile: risk limit in terms of downside**

**RISKS**

**Return goal: desired returns**

**RETURNS**
Quantitative measures for a comprehensive approach to risks disclosure in structured products

INVESTMENT HORIZON

(less than 3 years)

RISKS

(medium-low)

RETURNS

(maximum return)

... allow the investor to match his needs with the features of the financial products and to make an informed investment decision

PREVENT MISBUYING
Identification and representation of risk-reward by a three-pillars approach

Performance Risk w.r.t. the risk-free asset under the risk-neutral probability measure

… illustrates the unbundling of the price of the financial products at the time of subscription and provides clear and concise information about the possible outcomes and costs.

The three-pillars approach must be implemented via the proprietary models of risk management used by the industry, according to the general principles specified in the transparency regulation.
Identification and representation of risk-reward by a three-pillars approach

Connection between the risk-neutral price at time zero and at the end of recommended minimum investment horizon

Table of probabilistic performance scenarios

<table>
<thead>
<tr>
<th>Time Zero</th>
<th>End of the recommended investment horizon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Product’s simulated patterns</td>
<td>Product’s simulated patterns</td>
</tr>
</tbody>
</table>

Risk-Neutral Expected Value

\[ V_0 \]

Financial investment table

- (A) Invested Capital
- (B) Costs
- (C) = (A) + (B) Notional Capital
Identification and representation of risk-reward by a three-pillars approach

Unbundling of the financial investment at time zero

Financial investment table

- (A) Invested Capital
- (B) Costs
- (C) = (A) + (B) Notional Capital

Connection between the risk-neutral price at time zero and at the end of recommended minimum investment horizon

Returns probability distribution

Table of probabilistic performance scenarios
Identification and representation of risk-reward by a three-pillars approach

Connection between the risk-neutral price at time zero and at the end of the recommended minimum investment horizon

<table>
<thead>
<tr>
<th>Time Zero</th>
<th>Financial investment table</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A) Invested Capital</td>
<td>(B) Costs</td>
</tr>
<tr>
<td>(C) = (A) + (B) Notional Capital</td>
<td></td>
</tr>
</tbody>
</table>

End of the recommended investment horizon

<table>
<thead>
<tr>
<th>Table of probabilistic performance scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Event</td>
</tr>
<tr>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Positive and higher than risk-free asset</td>
</tr>
<tr>
<td>Positive and in line with risk-free asset</td>
</tr>
<tr>
<td>Positive but lower than risk-free asset</td>
</tr>
<tr>
<td>Negative</td>
</tr>
</tbody>
</table>

Probability Distribution of the final value of the Notional Capital invested in the risk-free asset

Probability Distribution of the final value of the Invested Capital

Probability Distribution of the final value of the Notional Capital invested in the risk-free asset

Probability Distribution of the final value of the Invested Capital

Identification and representation of risk-reward by a three-pillars approach

Table of probabilistic performance scenarios

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Identification and representation of risk-reward by a three-pillars approach

Identification and representation of risk-reward by a three-pillars approach

Identification and representation of risk-reward by a three-pillars approach
Identification and representation of risk-reward by a three-pillars approach

Table of probabilistic performance scenarios

- NC<sub>0</sub> 2.5% 97.5%

The performance is negative

The performance is positive but lower than the risk-free asset

The performance is positive and in line with the risk-free asset
Identification and representation of risk-reward by a three-pillars approach

Table of probabilistic performance scenarios

<table>
<thead>
<tr>
<th>EVENTS</th>
<th>PROBABILITY</th>
<th>MEDIAN RETURN</th>
</tr>
</thead>
<tbody>
<tr>
<td>The performance is negative</td>
<td>%</td>
<td>€</td>
</tr>
<tr>
<td>The performance is positive but lower than the risk-free asset</td>
<td>%</td>
<td>€</td>
</tr>
<tr>
<td>The performance is positive and in line with the risk-free asset</td>
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</tr>
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<td>%</td>
<td>€</td>
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</table>

1:1 Relationship
Identification and representation of risk-reward by a three-pillars approach

Model Risk Assessment

The Recommended Time Horizon has a significant influence on the choice of the model

For Time Horizons greater than 1 year.....

I  II

Step 1: Calculation of the Probability Distribution of the Notional Capital at the end of recommended time horizon

Step 2: Calculation of the Probability Distribution of the Invested Capital at the end of recommended time horizon

HESTON
Stochastic Volatility Model

BAKSHI CAO CHEN
Stochastic Volatility - Stochastic Interest Rate - Jump Model
Identification and representation of risk-reward by a three-pillars approach

Step 2: Calculation of the Probability Distribution of the Invested Capital at the end of recommended time horizon

Probability Distribution of the Risk-Free Asset

Step 3: Probabilistic comparison with the Risk-Free Asset

The following output is obtained:

<table>
<thead>
<tr>
<th>EVENT</th>
<th>PROBABILITY</th>
<th>MONDAY P Lưu</th>
<th>EVENT</th>
<th>PROBABILITY</th>
<th>MONDAY P Lưu</th>
</tr>
</thead>
<tbody>
<tr>
<td>The performance is negative</td>
<td>100%</td>
<td>0.00</td>
<td>The performance is positive but lower than risk-free</td>
<td>100%</td>
<td>0.00</td>
</tr>
<tr>
<td>The performance is positive and lower than risk-free</td>
<td>10.0%</td>
<td>0.20</td>
<td>The performance is positive and in line with risk-free</td>
<td>10.0%</td>
<td>0.20</td>
</tr>
<tr>
<td>The performance is positive and higher than risk-free</td>
<td>10.0%</td>
<td>0.20</td>
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</tr>
</tbody>
</table>

Assessing the model risk

<table>
<thead>
<tr>
<th>EVENT</th>
<th>PROBABILITY</th>
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<td>0.20</td>
</tr>
</tbody>
</table>

\[ |\Delta| = 2.40\% \]
Identification and representation of risk-reward by a three-pillars approach

Assessing the model risk

<table>
<thead>
<tr>
<th>Events</th>
<th>Heston</th>
<th>BCC</th>
</tr>
</thead>
<tbody>
<tr>
<td>The performance is negative</td>
<td>10%</td>
<td>10%</td>
</tr>
<tr>
<td>The performance is positive, but lower than risk-free rate</td>
<td>30%</td>
<td>30%</td>
</tr>
<tr>
<td>The performance is positive and in line with risk-free asset</td>
<td>40%</td>
<td>40%</td>
</tr>
<tr>
<td>The performance is positive, and higher than risk-free asset</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>

\[ |\Delta| = 3,29% \]

Identification and representation of risk-reward by a three-pillars approach

Assessing the model risk

<table>
<thead>
<tr>
<th>Events</th>
<th>Heston</th>
<th>BCC</th>
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</thead>
<tbody>
<tr>
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<td>40%</td>
</tr>
<tr>
<td>The performance is positive, and higher than risk-free asset</td>
<td>20%</td>
<td>20%</td>
</tr>
</tbody>
</table>

\[ |\Delta| = 2,22% \]

Identification and representation of risk-reward by a three-pillars approach

Assessing the model risk

<table>
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<tr>
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<td>20%</td>
</tr>
</tbody>
</table>

\[ |\Delta| = 3,11% \]

Identification and representation of risk-reward by a three-pillars approach

Synthetic Risk Indicator

... provides a description, on a qualitative scale, of the risk level of the financial products based on volatility measures.

... represents in an explicit way the riskiness of the product embedded in the probabilistic performance scenarios of the first pillar.
Identification and representation of risk-reward by a three-pillars approach

Synthetic Risk Indicator

The model has to take into account the following steps …

- Time evolution of the Volatility
- Mapping of the Qualitative Risk Classes into corresponding Volatility Intervals

Phase 1: Calibration of Volatility Intervals

Step 1: Definition of Loss Intervals

Step 2: Mapping of Loss Intervals to the corresponding Volatility Intervals

Step 3: Fine-tuning of Volatility Intervals

Step 1: Definition of Loss Intervals

What is a loss in a financial investment? 

Risk Neutrality Principle

\[ \text{LOSS} \in (-100\%, \bar{r}_f) \]

\( \bar{r}_f \) = average of the probability distribution of the risk-free rate

Risk-free yield curve and volatility surfaces
Identification and representation of risk-reward by a three-pillars approach

**Step 1: Definition of Loss Intervals**

The corresponding annual loss interval (multiple of $r_{\text{rf}}$ according to an exponential function) is associated to each risk class.

**Step 2: Mapping into Initial Volatility Intervals**

**Step 3: Fine-tuning of Volatility Intervals**

**TOOLS**

- GARCH Diffusive Models
- Non linear Stochastic Programming
The sequence \( \{X_h^h\} \), whose measurable space is \( \mathbb{R}^2 \), converges weakly for \( h \to 0 \) to the process \( \{X_h\} \) which has a unique distribution and is characterized by the following stochastic differential equation:

\[
dX_t = b(x, t)dt + \sigma(x, t)dW_{2,t}.
\]

where \( W_{2,t} \) is a two-dimensional standard Brownian motion, if the conditions 1-4, presented below, are satisfied.

---

**Step 3**: Fine-tuning of Volatility Intervals: GARCH Diffusive Models

**Condition**

**n. 2**

\[
\exists \sigma(x, t) \quad \text{s.t.} \quad \forall x_1 \in \mathbb{R}^1, \forall x_2 \in \mathbb{R}^1,
\]

\[
\begin{pmatrix}
\sigma(x_1, t) \\ 0
\end{pmatrix} = \begin{pmatrix}
\sqrt{a(x_1, t)} \\ 0
\end{pmatrix}
\]

\[
\begin{pmatrix}
0 \\ \sigma(x_2, t)
\end{pmatrix} = \begin{pmatrix}
0 \\ \sqrt{a(x_2, t)}
\end{pmatrix}
\]

---

**Conditions**

**n. 3**

For \( h \downarrow 0 \), \( X_h^h \) converges in distribution to a random variable \( X_0 \) with probability measure \( \nu_0 \) on \( \mathbb{R}^2 \), \( \mathbb{B}(\mathbb{R}^2) \)

**n. 4**

\( \nu_0 \), \( a(x, t) \), and \( b(x, t) \) uniquely specify the distribution of the process \( \{X_t\} \) characterized by an initial distribution \( \nu_0 \), a conditional second moment \( a(x, t) \), and a conditional first moment \( b(x, t) \).
Identification and representation of risk-reward by a three-pillars approach

Step 3: Fine-tuning of Volatility Intervals: GARCH Diffusive Models

The Continuous Limit of the M-GARCH(1,1)

\[ X_n - X_{n-1} = \gamma (X_{n-1} - \mu) + \sigma E dW_n \]

from the M-GARCH(1,1) statement

\[ \ln \sigma_{t+1} - \ln \sigma_t = \delta \ln \sigma_t + \beta_1 (\ln |Z_t| - 1) \ln \sigma_t + \beta_2 (\ln |Z_t| - 1) \ln \sigma_t \]

\[ \ln \sigma_{t+1} - \ln \sigma_t = 2 \ln (\exp(\ln |Z_t|) + 1) \]

\[ X_t \text{ and } Z_t \text{ is i.i.d. Normal} \]

Weak Convergence Theorem

\[ dX_t = \sigma_t (\mu - X_t) dt + \sigma_t dW_t \]

\[ d \ln \sigma_t = (\beta_1 - 2 \gamma E(\ln |Z|)) (\gamma - 1) \ln \sigma_t + 2 \beta_2 \sqrt{\gamma} \ln |Z_t| dW_t \]

\[ Z_t \text{ is Normal} \]

The Prediction Interval for the Volatility

key point

From the Diffusion Limit of the M-GARCH(1,1) Process

it is possible to establish a Predictive Interval for \( \sigma_t \)

Risk Classes

Management Style

Synthetic Risk Indicator

matching of the first two conditional moments

\[ \ln \sigma^2_k - \ln \sigma^2_{k-1} = \frac{[\delta_0 + \beta_1 \ln |Z_{k-1}|][\gamma (\beta_1 - 1)]}{\beta_1 - 1} - \right\]

\[ \left( \beta_1 - 1 \right) \ln \sigma^2_{k-1} + \right\]

\[ + 2 \beta_2 \ln \sigma_{k-1} \ln |Z_{k-1}| \]
Identification and representation of risk-reward by a three-pillars approach

**Step 3: Fine-tuning of Volatility Intervals**
GARCH Diffusive Models

Maximum likelihood estimation

\[ Y_k = \ln \sigma_k^2 - \ln \sigma_{k-1}^2 \]

\[ a = \left( \beta_0 + \beta_0 \ln (\ln \Delta x_{k-1}) \right) \left( \sigma_{k-1}^2 \right) - \left( \ln (\ln \Delta x_{k-1}) \right) \left( \sigma_{k-1}^2 \right) \]

\[ b = \left( \sigma_{k-1}^2 \right) \]

\[ \epsilon = \ln (\ln \Delta x_{k-1}) \]

\[ Z = \ln (\ln \Delta x_{k-1}) \]

**Synthetic Risk Indicator**

**Risk Classes**

**Management Style**
Identification and representation of risk-reward by a three-pillars approach

Step 3: Fine-tuning of Volatility Intervals

GARCH Diffusive Models

1. The Product Pattern is simulated for each Initial Volatility Interval

<table>
<thead>
<tr>
<th>Risk Classes</th>
<th>Volatility Intervals</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\sigma_{t,\text{min}}$</td>
</tr>
<tr>
<td>low</td>
<td>$\sigma_{t,\text{min}}$</td>
</tr>
<tr>
<td>medium-low</td>
<td>$\sigma_{t,\text{min}}$</td>
</tr>
<tr>
<td>medium</td>
<td>$\sigma_{t,\text{min}}$</td>
</tr>
<tr>
<td>medium-high</td>
<td>$\sigma_{t,\text{min}}$</td>
</tr>
<tr>
<td>high</td>
<td>$\sigma_{t,\text{min}}$</td>
</tr>
<tr>
<td>very high</td>
<td>$\sigma_{t,\text{min}}$</td>
</tr>
</tbody>
</table>

Synthetic Risk Indicator
Risk Classes
Management Style

Non linear Stochastic Programming

Drift
Continuous Uniform Distribution
E.D.S.
Continuous Triangular Distribution

Product Value
Identification and representation of risk-reward by a three-pillars approach

**Step 3: Fine-tuning of Volatility Intervals**

1. The Product Pattern is simulated for each Initial Volatility Interval

![Diagram showing simulation of product pattern](image)

2. Determination of the Time Series of the Annualized Volatility of Product Daily Returns

![Diagram showing time series of annualized volatility](image)

3. For each trajectory the Volatility forecast band is calculated using GARCH Diffusive Models

\[ \sigma_t = \text{Volatility Forecast Band} \]

![Diagram showing volatility forecast band](image)
Identification and representation of risk-reward by a three-pillars approach

**Step 3: Fine-tuning of Volatility Intervals**

4. Validation of Initial Volatility Interval through an iterative procedure that minimizes the number of observations outside the band

\[ \Delta = \left[ \text{Tot. } > \sigma_G^{\text{max}} \right] + \left[ \text{Tot. } < \sigma_G^{\text{min}} \right] / n^{*}250 \]

\[ \Delta_{\text{up}} = \left[ \text{Tot. } > \sigma_G^{\text{max}} \right] / n^{*}250 \]

\[ \Delta_{\text{down}} = \left[ \text{Tot. } < \sigma_G^{\text{min}} \right] / n^{*}250 \]

If \( \Delta > 5\% \)

*The Interval is updated*
Identification and representation of risk-reward by a three-pillars approach

**Step 3: Fine-tuning of Volatility Intervals**

- **Initial Interval** $[\sigma_{4\text{,min}}, \sigma_{4\text{,max}}]$
- **Product Value**
- **Annualized Volatility**
- **Forecast Band**

- **Update** $\Delta\sigma^\Delta > 0$
- **Forecast Band**

**VS**

**Garch Interval** $[\sigma_{4\text{,min}}, \sigma_{4\text{,max}}]$
Identification and representation of risk-reward by a three-pillars approach

**Step 3: Fine-tuning of Volatility Intervals**

<table>
<thead>
<tr>
<th>Synthetic Risk Indicator</th>
<th>Risk Classes</th>
<th>Management Style</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Interval</td>
<td>Product Value</td>
<td>Annualized Volatility</td>
</tr>
<tr>
<td>[ \sigma_{\text{min}} \sigma_{\text{max}} ]</td>
<td>[ \sigma_{\text{min}} \sigma_{\text{max}} ]</td>
<td>[ \sigma_{\text{min}} \sigma_{\text{max}} ]</td>
</tr>
</tbody>
</table>

Initial Interval

\[ \Delta \geq 5\% \]

VS

Garch Interval

\[ \sigma_{\text{min}} \sigma_{\text{max}} \]

Forecast Band

\[ \Delta < \Delta_{\text{Min}} \]

Synthetic Risk Indicator

Risk Classes

Management Style

END PROCEDURE

<table>
<thead>
<tr>
<th>Initial Interval</th>
<th>Product Value</th>
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Initial Interval

\[ \Delta \leq 5\% \]

VS

Garch Interval

\[ \sigma_{\text{min}} \sigma_{\text{max}} \]

Forecast Band

\[ \Delta > 5\% \]

Synthetic Risk Indicator

Risk Classes

Management Style

END PROCEDURE
### Identification and representation of risk-reward by a three-pillars approach

#### Synthetic Risk Indicator

The model has to take into account the following steps...

- **Time evolution of the “intensity” of the Management Style**
- **Mapping of each Volatility Interval into corresponding Intervals of a suitable Volatility Measure for every Management Style**

#### Synthetic Risk Indicator

- **Output**
  - **Risk Classes**
    - Low
    - Medium-Low
    - Medium
    - Medium-High
    - High
    - Very High
  - **Volatility Intervals**
    - \(\sigma_{\text{min}}\)
    - \(\sigma_{\text{max}}\)
  - \(\sigma_{\text{min}}\): 0.01% to 25.00%
  - \(\sigma_{\text{max}}\): 0.49% to 25.00%

#### Synthetic Risk Indicator

- **Time evolution of the Volatility**
- **Mapping of the Qualitative Risk Classes into corresponding Volatility Intervals**

### Identification and representation of risk-reward by a three-pillars approach

#### Synthetic Risk Indicator

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### Identification and representation of risk-reward by a three-pillars approach

#### Synthetic Risk Indicator

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#### Synthetic Risk Indicator

- **Time evolution of the “intensity” of the Management Style**
- **Mapping of each Volatility Interval into corresponding Intervals of a suitable Volatility Measure for every Management Style**
Identification and representation of risk-reward by a three-pillars approach

The recommended minimum investment horizon

Investment period which can be deemed appropriate having regard to the risk-reward profile and to the costs of the product

… for performance target products and for guaranteed products the recommended minimum investment horizon is inherent to their financial engineering, as:

the recommended minimum investment horizon is

the period of validity (or the time to maturity) of their target/guarantee mechanisms
Identification and representation of risk-reward by a three-pillars approach

The recommended minimum investment horizon

... for risk target products or benchmark products is calculated as the break-even time of the financial investment, i.e. the time needed to recover the initial charges and to offset the ongoing costs at least once, from a probabilistic perspective.

Formally speaking, the probability of the event

The investment recovers the initial charges and offsets the ongoing costs at least once

can be calculated using the mathematical concept of

First Hitting Time

Identification and representation of risk-reward by a three-pillars approach

First Hitting Time of a Structured Product:

first time (expressed in years) at which the value of the product recovers the initial cost and offsets the ongoing costs

The probability of the event

The investment recovers the initial charges and offsets the ongoing costs at least once

is perfectly represented using the cumulative distribution of first hitting times, i.e:

\[ P[t^* \leq T] = \lambda \% \]

where

\[ t^* = \inf \{ t \in \mathbb{R} : CI > CN \} \]

is the first hitting time
Identification and representation of risk-reward by a three-pillars approach

The recommended minimum investment horizon

The probability of the event

The investment recovers the initial charges and offsest the ongoing costs at least once

given a level of confidence $\alpha$, identifies univocally a time $T$ on the cumulative distribution of first hitting times, i.e.:

$$T^* = \{ t \in \mathbb{R} : P[t^* \leq T] = \alpha \}$$

where

$$t^* = \inf \{ t \in \mathbb{R} : CI > CN \}$$

is the first hitting time

Identification and representation of risk-reward by a three-pillars approach

Computational Steps

1. The First Hitting Time Distribution of the Structured Product is calculated:
Identification and representation of risk-reward by a three-pillars approach

2. The First Hitting Time Cumulative Distribution of the Structured Product is then represented:

The recommended minimum investment horizon $0$ $1$ $2$ $3$ $4$ $5$ $6$ $7$ $8$ $9$ $10$ $0.975$ $1$

$F(x)$ Empirical CDF

Identification and representation of risk-reward by a three-pillars approach

3. The level of confidence $\alpha$ identifies univocally $T$ on the cumulative distribution of first hitting times:

The recommended minimum investment horizon $0$ $1$ $2$ $3$ $4$ $5$ $6$ $7$ $8$ $9$ $10$ $0.975$ $1$

$F(x)$ Empirical CDF

Identification and representation of risk-reward by a three-pillars approach

The recommended minimum investment horizon is heavily dependent from the measured level of volatility:

The recommended minimum investment horizon $0$ $1$ $2$ $3$ $4$ $5$ $6$ $7$ $8$ $9$ $10$ $0.975$ $1$

$F(x)$ Empirical CDF
Identification and representation of risk-reward by a three-pillars approach

The recommended minimum investment horizon is heavily dependent from the measured level of volatility:

Identification and representation of risk-reward by a three-pillars approach

The recommended minimum investment horizon is heavily dependent from the level of initial charges and ongoing costs:

Identification and representation of risk-reward by a three-pillars approach

The recommended minimum investment horizon is heavily dependent from the level of initial charges and ongoing costs:
The key qualitative information is made objective by using a three-pillars approach based on quantitative measures.