9

MARKET RISK

IN BRIEF

Market risk is the risk of loss of value on financial instruments arising from changes in market parameters, the volatility of these parameters and the correlations between them. These parameters include, but are not limited to, exchange rates, interest rates, the price of securities (equities or bonds), commodities, derivatives and other assets.

Market risk RWA at end 2022

€13.8bn

(Amount at end 2021: €11.6bn)

Annual average VaR
(1 day, 99%) - 2022

€18m

(Annual average VaR 2021: €15m)

Share of RWA calculated
via the internal model

86%

Market risk is the risk of loss of value on financial instruments arising from changes in market parameters, the volatility of these parameters, and the correlations between them. These parameters include, but are not limited to, exchange rates, interest rates, the price of securities (equities or bonds), commodities, derivatives and other assets.

9.1 ORGANISATION OF MARKET RISK MANAGEMENT

Main functions

Although primary responsibility for managing risk exposure relies on the front office managers, the supervision system comes under the Market Risk Department of the Risk Department, which is independent from the businesses.

The main missions of this department are:

- the definition and proposal of the Group's market risk appetite;
- the proposal of appropriate market risk limits by Group activity to the Group Risk Committee (CORISQ);
- the assessment of the limit requests submitted by the different businesses within the framework of the overall limits authorised by the Board of Directors and General Management, and based on the use of these limits;
- the permanent verification of the existence of an effective market risk monitoring framework based on suitable limits;
- the definition of the indicators used to monitor market risk;
- the daily calculation and certification of the market risk indicators, of the P&L resulting from market activities, based on formal and secure procedures, and then of the reporting and the analysis of these indicators;
- the daily monitoring of the limits set for each activity.

In order to perform its tasks, the department also defines the architecture and the functionalities of the information system used to produce the risk and P&L indicators for market transactions, and ensures it meets the needs of the different businesses and of the Market Risk Department.

This department contributes to the detection of possible rogue trading operations through a monitoring mechanism based on alert levels (on gross nominal value of positions for example) applied to all instruments and desks.

Governance

Market risks oversight is provided by various Committees at different levels of the Group:

- the Risk Committee of the Board of Directors[1] is informed of the Group's major market risks; in addition, it issues a recommendation on the most substantial proposed changes in terms of market risk measurement and framework (after prior approval by the CORISQ); this recommendation is then referred to the Board of Directors for a decision;
- the Group Risk Committee[2] (CORISQ), chaired by the Chief Executive Officer of the Group (DGLE), is regularly informed of Group-level market risks. Moreover, upon a proposal from the Risk Department, it validates the main choices with regard to market risk measurement, as well as the key developments on the architecture and implementation of the market risk framework at Group level. The global market risk limits with a Board or DGLE delegation level are reviewed in CORISQ at least twice a year;
- the market risks related to the Global Markets Division are reviewed during the Market Risk Committee[3] (MRC) led by the Market Risk Department and co-chaired by the Risk Department and by the Global Markets Division. This Committee provides information on risk levels for the main risk indicators as well as for some specific activities pointed out depending on market or business driven events. It also provides an opinion on the market risk framework changes falling under the remit of the Risk Department and Global Markets Division. Thus, the global market risk limits with a MARK/DIR – RISQ/DIR delegation level are reviewed in MRC at least twice a year.

During these Committees, the market activities P&L and several metrics for monitoring market risks are reported:

- stress test measurements: Global Stress Test on market activities and Market Stress Test;
- regulatory metrics: Value-at-Risk (VAR) and Stressed Value-at-Risk (SVAR).

In addition to these Committees, detailed and summary market risk reports, produced on a daily, weekly, monthly or quarterly basis, either related to various Group levels or geographic areas, are sent to the relevant business line and risk function managers.

In terms of governance, within the Market Risk Department, the main functional and transversal subjects are dealt with during Committees organised by value chains (market risk, P&L, etc.). These Committees are decision-making bodies, composed of senior representatives from each relevant Department teams and regions.

(1) Gathered ten times in 2022 on topics related to market activities.
(2) Seven CORISQ dedicated to market activities took place in 2022.
(3) Gathered 11 times in 2022.

9.2 MARKET RISK MONITORING PROCESS

Market risk appetite

The business development strategy of the Group for market activities is primarily focused on meeting clients' needs, with a comprehensive range of products and solutions. The risk resulting from these market activities is strictly managed through a set of limits for several indicators:

- the Value-at-Risks (VaR) and stressed Value-at-Risks (sVaR): these global indicators are used for market risk calculations for RWA and for the day-to-day monitoring of the market risks incurred by the Group within the scope of its trading activities;
- stress test measurements, based on decennial shock-type indicators, which make it possible to restrict the Group's exposure to systemic risk and exceptional market shocks. These measurements can be global, multi-risk factor (based on historic or hypothetical scenarios), by activity or risk factor in order to take into account extreme risks on a specific market, or event-driven, to temporarily monitor a particular situation;
- sensitivity and nominal indicators used to manage the size of positions:
  - sensitivities are used to monitor the risk incurred locally on a given type of position (*e.g.* sensitivity of an option to changes in the underlying asset),
  - while nominal indicators are used for significant positions in terms of risk;
- additional indicators such as concentration risk or holding period, maximum maturity, etc.

The Market Risk Department is responsible for the assessment and validation of the limit requests submitted by the different business lines. These limits ensure that the Group complies with the market risk appetite approved by the Board of Directors.

Determining and monitoring limits

The choice and calibration of these limits ensure the operational transposition of the Group's market risk appetite through its organisation:

- these limits are allocated at various levels of the Group's structure and/or by risk factor;
- their calibration is determined using a detailed analysis of the risks related to the portfolio managed. This analysis may include various elements such as market conditions, specifically liquidity, position maneuverability, risk/rewards analysis, ESG criteria, etc.;
- regular reviews make it possible to manage risks according to the prevailing market conditions;
- specific limits, or even bans, may be put in place to manage risks for which the Group has little or no risk appetite.

The desk mandates and Group policies stipulate that the traders must have a sound and prudent management of positions and must respect the defined frameworks. The allowed transactions, as well as risk hedging strategies, are also described in the desk mandates. The limits set for each activity are monitored daily by the Market Risk Department. This continuous monitoring of the market risk profile is the object of regular discussions between the risk and business teams, further to which various risk hedging or mitigation initiatives may be taken by the front office in order to remain within the defined limits. In the event of a breach of the risk framework, and in compliance with the limits follow-up procedure, the front office must detail the reasons, and take the necessary measures to return within the defined framework, or otherwise request a temporary or permanent increase of limit if the client's request and if market conditions justify such a course of action.

In addition to the governance structure in place between the various departments of the Risk function and business lines, the monitoring of limits usage, due to the products/solutions provided to clients and the market-making activities, also contributes to ensuring that market risk to which the Group is exposed are properly managed and understood.

9.3 MAIN MARKET RISK MEASURES

Stress test assessment

Societe Generale monitors its exposure using stress test simulations to take into account exceptional market disruptions.

A stress test estimates the loss resulting from an extreme change in market parameters over a period corresponding to the time required to unwind or hedge the positions affected.

Two major metrics are defined and used:

- the Global Stress Test on market activities, which estimates the losses linked to market risks, market/counterparty cross-risk, and dislocation and carry risk on exotic activities, that could arise simultaneously in the event of a severe but plausible systemic crisis. This stress test is modeled on five scenarios;
- the Market Stress Test, which focuses solely on market risks, applying the same scenarios as the Global Stress Test and additional scenarios corresponding to different market conditions.

The various scenarios for those stress tests are reviewed by the Risk Division on a regular basis. These reviews are presented during dedicated biannual Committees, chaired by the Market Risk Department and attended by economists and representatives of Societe Generale's trading activities. These Committees cover the following topics: changes in scenarios (introduction, removal, shock review), appropriate coverage of the risk factors by the scenarios, review of the approximations made in terms of calculation, correct documentation of the whole process. The delegation level needed to validate the changes in stress test methodology depends on the impact of the change in question.

The Global Stress Test on market activities limits and the Market Stress Test limits play a central role in the definition and the calibration of the Group's appetite for market risk: these indicators cover all activities and the main market risk factors and associated risks associated with a severe market crisis, this allows both to limit the overall amount of risk and to take into account any diversification effects.

This framework is complemented by stress-testing frameworks on four risk factors on which the Group has significant exposures, in order to reduce the overall risk appetite: equities, interest rates, credit spread and emerging markets.

GLOBAL STRESS TEST ON MARKET ACTIVITIES

The Global Stress Test on market activities is the main risk indicator used on this scope. It covers all the risks on market activities that would occur simultaneously in case of a severe, but plausible, market crisis. The impact is measured over a short period of time with an expected occurrence of once per decade. The Global Stress Test uses five market scenarios and has three components, each of which are considered in each of the five scenarios in order to ensure consistency within the same scenario:

- market risk;
- dislocation and carry risks on exotic activities related to concentration effects and crowded trades;
- market/counterparty cross-risks arising in transactions with weak counterparties (hedge funds and proprietary trading groups).

The Global Stress Test corresponds to the least favorable results arising from the five scenarios and their respective components.

Market risk component

It corresponds to:

- the results of the Market Stress Test[1] restricted to scenarios that could cause dislocation effects on market positions and default by weak counterparties. These scenarios all simulate a sharp fall in the equity markets and a widening in credit spreads which could trigger dislocation effects. Following the last review of the scenarios at the end of 2020, it was decided to use for the calculation of the stress test three theoretical scenarios (generalised (*i.e.* financial crisis scenario), eurozone crisis, general decline in risk assets) and two historical scenarios focusing respectively on the period of early October 2008 and early March 2020;
- the impact of the stress test scenario on CVA (Credit Value Adjustment) and FVA (Funding Value Adjustment) reserves, as their variations affect trading results.

Dislocation and carry risk component

Additional market risks to those assessed in the Market Stress Test can occur in market situation in which one or more participants – generally structured products sellers – have concentrated or crowded trades. Dynamic risk hedging strategies can cause larger market dislocations than those calibrated in the Market Stress Test, and these dislocations can extend beyond the shock timeline used due to an imbalance between supply and demand.

Equity, credit, fixed income, currency and commodity trading activities are regularly reviewed to identify these areas of risk and to define a scenario that takes into account the specific features of each activity and position. Each scenario associated with an identified area of risk is added to the market risk component if – and only if – it is compatible with the market scenario in question.

Market/counterparty cross-risk component on weak counterparties

Some counterparties may be significantly affected by a major crisis on the financial markets and their probability of default may increase. The third component of the Global Stress Test therefore aims to take into account this increased risk on certain types of weak counterparties (hedge funds and proprietary trading groups).

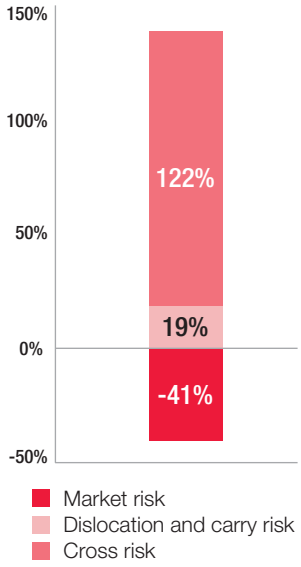
Four measurements are used:

- **the collateralised financing stress test:** this stress test focuses on collateralised financing activities and more specifically on weak counterparties. It applies a dislocation shock to several asset classes with the assumption of extremely tight liquidity conditions. Collateral and counterparty default rates are stressed concomitantly, taking into account any consanguinity with the collateral posted;
- **the adverse stress test on hedge funds and proprietary trading groups (PTG):** this stress test applies three pairs of stress scenarios to all market transactions generating replacement regarding this type of counterparty. Each set of scenarios consists of a short-term scenario (scenario derived from the Market Stress Test) applied to positions with margin calls, and a long-term scenario (whose shocks are generally more severe) for positions without margin calls. Stressed current exposures are weighted by the probability of default of each counterparty and by the loss given default (LGD), then aggregated;

(1) Measurement of the impact in the Net Banking Product in case of shocks on all risk factors (refer to description below).

- **the adverse stress test on products whose underlying is a hedge fund:** this type of underlying poses a risk of illiquidity in the event of a crisis, the purpose of this stress test is to estimate the corresponding potential loss on transactions with this type of underlying and presenting a "gap risk";
- **the Clearing House (CCP) Member stress test:** it estimates the potential loss in the event of a default of a CCP member of which Societe Generale is also a member.

AVERAGE CONTRIBUTION OF THE COMPONENTS IN 2022 GLOBAL STRESS TEST ON MARKET ACTIVITIES



MARKET STRESS TEST

This metric focuses on market risk and estimates the loss resulting from shocks on the set of risk factors. This stress test is based on 11 scenarios[1] (four historical and seven hypothetical). The main principles are as follows:

- the scenario considered in the market stress test is the worst of the different scenarios defined;
- the shocks applied are calibrated on time horizons specific to each risk factor (the time horizon can range from five days for the most liquid risk factors to three months for the least liquid);
- risks are calculated every day for each of the Bank's market activities (all products together), using each of the historical and hypothetical scenarios.

Historical scenarios

This method consists of an analysis of the major economic crises that have affected the financial markets: changes in the prices of financial assets (equities, interest rates, exchange rates, credit spreads, etc.) during each of these crises have been analysed in order to define scenarios for potential variations in these main risk factors which, when applied to the Bank's trading positions, could generate significant losses. Accordingly, this approach makes it possible to determine the historical scenarios used for the calculation of the stress test. This set of scenarios is also the subject of regular reviews. In 2020, two new historical scenarios related to the Covid-19 crisis were integrated: a crisis scenario (marked by a decline in equity indices and an increase in credit spreads) as well as a rebound scenario (marked by an increase in equity indices and a decrease in credit spreads). Societe Generale is currently using four historical scenarios in the calculation of the stress test, which cover the periods from October to December 2008 and March 2020.

Hypothetical scenarios

The hypothetical scenarios are defined with the Group's economists and are designed to identify possible sequences of events that could lead to a major crisis in the financial markets (*e.g.* European crisis, a drop in assets, etc.). The Group's aim is to select extreme but plausible events which would have major repercussions on all international markets. Accordingly, Societe Generale has defined seven hypothetical scenarios.

Regulatory indicators

99% VALUE-AT-RISK (VAR)

Methodology

The Internal VaR Model was introduced at the end of 1996 and has been approved by the French regulator within the scope of the regulatory capital requirements. This approval was renewed in 2020 at the Target Review of Internal Models (TRIM).

The Value-at-Risk (VaR) assesses the potential losses on positions over a defined time horizon and for a given confidence interval (99% for Societe Generale). The method used is the "historical simulation" method, which implicitly takes into account the correlation between the various markets, as well as general and specific risk. It is based on the following principles:

- storage in a database of the risk factors that are representative of Societe Generale's positions (*i.e.* interest rates, share prices, exchange rates, commodity prices, volatility, credit spreads, etc.). Controls are regularly performed in order to check that all major risk factors for the trading portfolio of the Group are taken into account by the internal VaR model;
- definition of 260 scenarios corresponding to one-day variations in these market parameters over a rolling one-year period; these scenarios are updated daily with the inclusion of a new scenario and the removal of the oldest scenario. There are three coexisting methods for modeling scenarios (relative shocks, absolute shocks and hybrid shocks), the choice between these methods for a given risk factor is determined by its nature and its historical trend;
- the application of these 260 scenarios to the market parameters of the day;
- revaluation of daily positions, on the basis of the 260 sets of adjusted market parameters: in most cases this calculation involves a full repricing. Nonetheless, for certain risk factors, a sensitivity-based approach may be used.

(1) Including the scenarios used in the global stress tests on market activities.

Main risk factors	Description
Interest rates	Risk resulting from changes in interest rates and their volatility on the value of a financial instrument sensitive to interest rates, such as bonds, interest rate swaps, etc.
Share prices	Risk resulting from variations in prices and volatility of shares and equity indices, in the level of dividends, etc.
Exchange rates	Risk resulting from the variation of exchange rates between currencies and of their volatility.
Commodity prices	Risk resulting from changes in prices and volatility of commodities and commodity indices.
Credit Spreads	Risk resulting from an improvement or a deterioration in the credit quality of an issuer on the value of a financial instrument sensitive to this risk factor such as bonds, credit derivatives (credit default swaps for example).

Within the framework described above, the one-day 99% VaR, calculated according to the 260 scenarios, corresponds to the weighted average[1] of the second and third largest losses computed, without applying any weighting to the other scenarios.

The day-to-day follow-up of market risk is performed *via* the one-day VaR, which is calculated on a daily basis at various granularity levels. Regulatory capital requirements, however, oblige us to take into account a ten-day horizon, thus we also calculate a ten-day VaR, which is obtained by multiplying the one-day VaR aggregated at Group level by the square root of ten. This methodology complies with regulatory requirements and has been reviewed and validated by the regulator.

The VaR assessment is based on a model and a certain number of conventional assumptions, the main limitations of which are as follows:

- by definition, the use of a 99% confidence interval does not take into account losses arising beyond this point; VaR is therefore an indicator of the risk of loss under normal market conditions and does not take into account exceptionally significant fluctuations;
- VaR is computed using closing prices, meaning that intraday fluctuations are not taken into account;
- the use of a historical model is based on the assumption that past events are representative of future events and may not capture all potential events.

The Market Risk Department monitors the limitations of the VaR model by measuring the impacts of integrating a risk factor absent from the model (RNIME[2] process). Depending on the materiality of these missing factors, they may be capitalized. Other complementary measures also allow to control the limitations of the model.

The same model is used for the VaR computation for almost all of Global Banking & Investor Solution's activities (including those related to the most complex products) and the main market activities of Retail Banking and Private Banking. The few activities not covered by the VaR method, either for technical reasons or because the stakes are too low, are monitored using stress tests, and capital charges are calculated using the standard method or through alternative in-house methods. For example, the currency risk of positions in the banking book is not calculated with an internal model because this risk is not subject to a daily revaluation and therefore cannot be taken into account in a VaR calculation.

Backtesting

The relevance of the model is checked through continuous backtesting in order to verify whether the number of days for which the negative result exceeds the VaR complies with the 99% confidence interval. The results of the backtesting are audited by the Risk Department in charge of the validation of internal models, which, as second line of defence, also assesses the theoretical robustness (from a design and development standpoint), the correctness of the implementation and the adequacy of the model use. The independent review process ends with (i) review and approval Committees and (ii) an Audit Report detailing the scope of the review, the tests performed and their outcomes, the recommendations and the conclusion of the review. The model control mechanism gives rise to reporting to the appropriate authorities.

In compliance with regulations, backtesting compares the VaR to the (i) actual and (ii) hypothetical change in the portfolio's value:

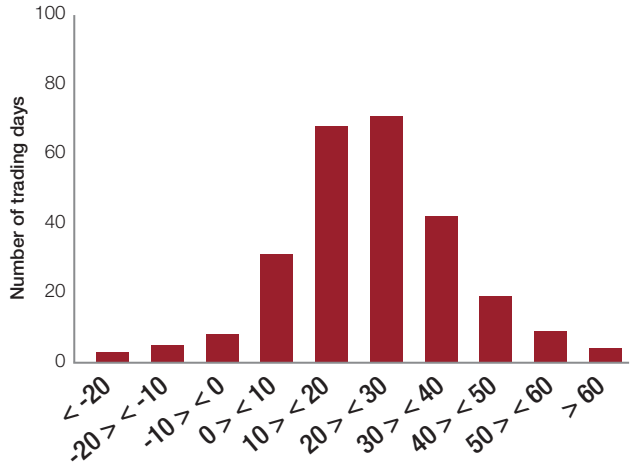
- in the first case (backtesting against "actual P&L"), the daily P&L[3] includes the change in book value, the impact of new transactions and of transactions modified during the day (including their sales margins) as well as provisions and values adjustments made for market risk;
- in the second case (backtesting against "hypothetical P&L"), the daily P&L[4] includes only the change in book value related to changes in market parameters and excludes all other factors.

In 2022, we observed:

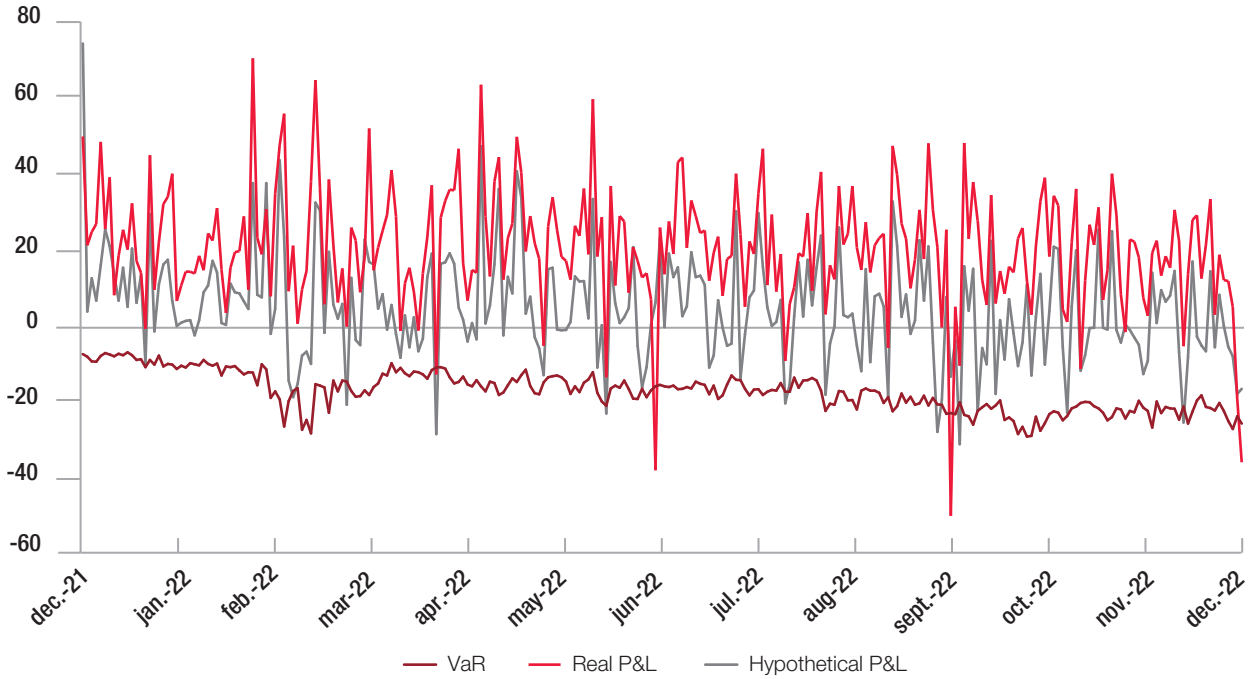
- four VaR backtesting, against actual P&L breaches (two in Q2, one in Q3 and one in Q4);
- eight VaR backtesting breaches, against hypothetical P&L (two breaches each quarter).

(1) 39% of the second highest risk and 61% of the third highest risk.
(2) Risk Not In Model Engine.
(3) "Actual P&L" by agreement hereinafter.
(4) "Hypothetical P&L" by agreement hereinafter.

BREAKDOWN OF THE DAILY[1] P&L OF MARKET ACTIVITIES (2022, IN EURM)



TRADING VAR (ONE-DAY, 99%), DAILY ACTUAL[2] P&L AND DAILY HYPOTHETICAL[3] P&L OF THE TRADING PORTFOLIO (2022, IN EURM)



(1) Actual P&L.
(2) Daily result used for backtesting the VaR against the effective value of the portfolio as defined in the paragraph "Value-at-Risk 99% (VaR)".
(3) Daily result used for backtesting the VaR against the hypothetical value of the portfolio as defined in the paragraph "Value-at-Risk 99% (VaR)".

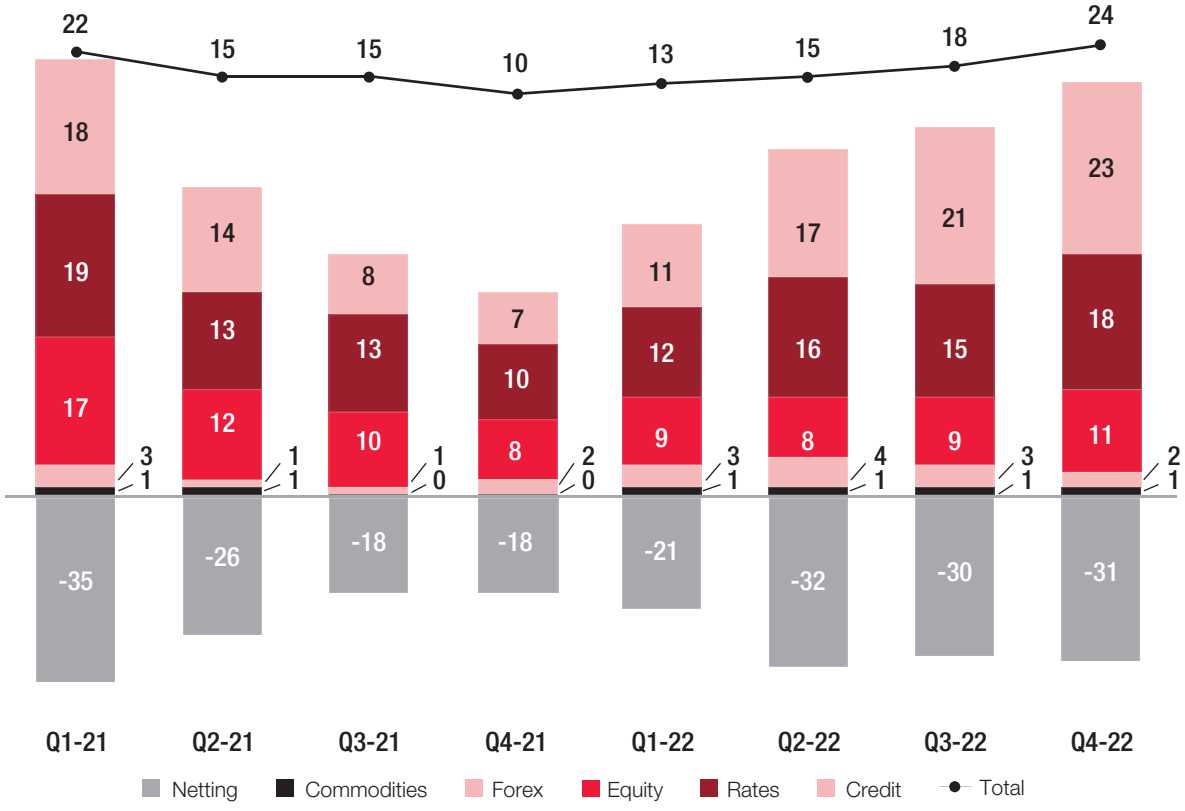
VaR Changes

TABLE 88: REGULATORY TEN-DAY 99% VAR AND ONE-DAY 99% VAR

	31.12.2022		31.12.2021	
(In EURm)	VaR (10 days, 99%)[1]	VaR (1 day, 99%)[1]	VaR (10 days, 99%)[1]	VaR (1 day, 99%)[1]
Period start	25	8	75	24
Maximum value	95	30	98	31
Average value	56	18	49	15
Minimum value	22	7	18	6
Period end	75	24	25	8

(1) Over the scope for which capital requirements are assessed by internal model.

BREAKDOWN BY RISK FACTOR OF TRADING VAR (ONE-DAY, 99%) – CHANGES IN QUARTERLY AVERAGE OVER THE 2021-2022 PERIOD (IN EURM)



The VaR was riskier in 2022 (EUR 18 million *versus* EUR 15 million in 2021 on average), mainly due to the entry of new and more volatile scenarios following the deterioration of market conditions related to the war in Ukraine. The increase in risk is particularly evident in the Rates and Credit activities.

STRESSED VAR (SVAR)

The Internal Stressed VaR model (SVaR) was introduced at the end of 2011 and has been approved by the Regulator within the scope of the regulatory capital requirements on the same scope as the VaR. As with the VaR model, this approval was renewed in 2020 at the Target Review of Internal Models (TRIM).

The calculation method used for the 99% one-day SVaR is the same as as the one for the VaR. It consists in carrying out a historical simulation with one-day shocks and a 99% confidence interval. Contrary to VaR, which uses 260 scenarios for one-day fluctuations over a rolling one-year period, SVaR uses a fixed one-year historical window corresponding to a period of significant financial tension.

Following a validation of the ECB obtained at the end of 2021, a new method for determining the fixed historical stress window is used. It consists in calculating an approximate SVaR for various risk factors selected as representative of the Societe Generale portfolio (related to equity, fixed income, foreign exchange, credit and commodity risks): these historical shocks are weighted according to the portfolio's sensitivity to each of these risk factors and aggregated to determine

the period of highest stress for the entire portfolio[1]. The historical window used is reviewed annually. In 2022, this window was "September 2008-September 2009".

The ten-day SVaR used for the computation of the regulatory capital is obtained, as for VaR, by multiplying the one-day SVaR by the square root of ten.

As for the VaR, the Market Risk Department controls the limitations of the SVaR model by measuring the impact of integrating a risk factor absent from the model (RNIME process). Depending on the materiality of these missing factors, they may be capitalized. Other complementary measures also control the limitations of the model. The continuous backtesting performed on VaR model cannot be replicated to the SVaR model as, by definition, it is not sensitive to the current market conditions. However, as the VaR and the SVaR models rely on the same approach, they have the same advantages and limitations.

The relevance of the SVaR is regularly monitored and reviewed by the Risk Department in charge of the validation of internal models, as second line of defence. The independent review process ends with (i) review and approval Committees and (ii) an Audit Report detailing the scope of the review, the tests performed and their outcomes, the recommendations and the conclusion of the review. The model control mechanism gives rise to recurrent reporting to the appropriate authorities.

SVaR decreased slightly on average in 2022 (EUR 32 million *versus* EUR 37 million in 2021 on average). Without any particular trend over the year, the SVaR has evolved at levels similar to those of 2021 and with comparable variability. The level of the SVaR remains explained by the indexing and financing action activities, and by the interest rate scopes, while the exotic scopes partially offset the risk.

TABLE 89: REGULATORY TEN-DAY 99% SVAR AND ONE-DAY 99% SVAR

	31.12.2022		31.12.2021	
(In EURm)	**Stressed VaR (10 days, 99%)[1]**	**Stressed VaR (1 day, 99%)[1]**	**Stressed VaR (10 days, 99%)[1]**	**Stressed VaR (1 day, 99%)[1]**
Period start	96	30	135	43
Maximum value	165	52	191	60
Average value	101	32	117	37
Minimum value	55	17	72	23
Period end	145	46	108	34

(1) Over the scope for which capital requirements are assessed by internal model.

IRC AND CRM

At end-2011, Societe Generale received approval from the Regulator to expand its internal market risk modeling system by including IRC (Incremental Risk Charge) and CRM (Comprehensive Risk Measure), for the same scope as for VaR. As with the VaR model, the approval of the IRC[2] model was renewed in 2020 at the Target Review of Internal Models (TRIM).

They estimate the capital charge on debt instruments that is related to rating migration and issuer default risks. These capital charges are incremental, meaning they are added to the charges calculated based on VaR and SVaR.

In terms of scope, in compliance with regulatory requirements:

- IRC is applied to debt instruments, other than securitisations and the credit correlation portfolio. In particular, this includes bonds, CDS and related derivatives;
- CRM exclusively covers the correlation portfolio, *i.e.* CDO tranches and First-to-Default products (FtD), as well as their hedging using CDS and indices.

Societe Generale estimates these capital charges using internal models[3]. These models determine the loss that would be incurred following especially adverse scenarios in terms of rating changes or issuer defaults for the year that follows the calculation date, without ageing the positions. IRC and CRM are calculated with a confidence interval of 99.9%: they represent the highest risk of loss obtained after eliminating 0.1% of the most unfavorable scenarios simulated.

The internal IRC model simulates rating transitions (including default) for each issuer in the portfolio, over a one-year horizon[4]. Issuers are classified into five categories: US-based companies, European companies, companies from other regions, financial institutions and sovereigns. The behaviours of the issuers in each category are correlated with one other through a systemic factor specific to each category. In addition, a correlation between these five systemic factors is integrated to the model. These correlations, along with the rating transition probabilities, are calibrated from historical data observed over the course of a full economic cycle. In case of change in an issuer's rating, the decline or improvement in its financial health is modeled by a shock in its credit spread: negative if the rating improves and positive in the opposite case. The price variation associated with each IRC scenario is determined after revaluation of positions *via* a sensitivity approach, using the delta, the gamma as well as the level of loss in the event of default (Jump to Default), calculated with the market recovery rate for each position.

(1) At the request of the ECB, a posteriori check is carried out to verify the relevance of this historical window by making calculations for full revaluation.
(2) The CRM model was not within the scope of the Target Review of Internal Models.
(3) The same internal model is used for all portfolios for which an IRC calculation is required. The same is true for the portfolios on which a CRM calculation is performed. Note that the scope covered with internal models (IRC and CRM) is included in the VaR scope: only entities authorised for a VaR calculation via an internal model can use an internal model for IRC and CRM calculation.
(4) The use of a constant one-year liquidity horizon means that shocks that are applied to the positions to calculate IRC and CRM, are instantaneous one-year shocks. This hypothesis appears to be the most prudent choice in terms of models and capital, rather than shorter liquidity horizons.

The CRM model simulates issuer's rating transitions in the same way as the internal IRC model. In addition, the dissemination of the following risk factors is taken into account by the model:

- credit spreads;
- basis correlations;
- recovery rate excluding default (uncertainty about the value of this rate if the issuer has not defaulted);
- recovery rate in the event of default (uncertainty about the value of this rate in case of issuer default);
- First-to-Default valuation correlation (correlation of the times of default used for the valuation of the First-to-Default basket).

These dissemination models are calibrated from historical data, over a maximum period of ten years. The price variation associated with each CRM scenario is determined thanks to a full repricing of the positions. In addition, the capital charge computed with the CRM model cannot be less than a minimum of 8% of the capital charge determined with the standard method for securitisation positions.

The internal IRC and CRM models are subject to similar governance to that of other internal models meeting the Pillar 1 regulatory requirements. More specifically, an ongoing monitoring allows to follow the adequacy of IRC and CRM models and of their calibration. This monitoring is based on the review of the modeling hypotheses at least once a year. This review includes:

- a check of the adequacy of the structure of the rating transition matrices used for IRC and CRM models;
- a backtesting of the probabilities of default used for these two models;
- a check of the adequacy of the models for the dissemination of recovery rates, spread dissemination and dissemination of basic correlations used in the CRM calculation.

Regarding the checks on the accuracy of these metrics:

- the IRC calculation being based on the sensitivities of each instrument – delta, gamma – as well as on the level of loss in the event of default (Jump to Default) calculated with the market recovery rate, the accuracy of this approach is checked against a full repricing every six months;
- such a check on CRM is not necessary as its computation is performed following a full repricing;
- these metrics are compared to normative stress tests defined by the regulator. In particular, the EBA stress test and the risk appetite exercise are performed regularly on the IRC metric. These stress tests consist of applying unfavorable rating migrations to issuers, shocking credit spreads and shocking rating transition matrices. Other stress tests are also carried out on an *ad hoc* basis to justify the correlation hypotheses between issuers and those made on the rating transition matrix;
- a weekly analysis of these metrics is carried out by the production and certification team for market risk metrics;
- the methodology and its implementation have been initially validated by the French Prudential and Resolution Supervisory Authority (*Autorité de contrôle prudentiel et de résolution* – ACPR). Thereafter, a review of the IRC and the CRM is regularly carried out by the Risk Department in charge of the validation of internal models as second line of defence. This independent review process ends with (i) review and approval Committees and (ii) an Audit Report detailing the scope of the review, the tests performed and their outcomes, the recommendations and the conclusion of the review. The model control mechanism gives rise to recurrent reporting to the appropriate authorities.

Moreover, regular operational checks are performed on the completeness of the scope's coverage as well as the quality of the data describing the positions.

TABLE 90: IRC (99.9%) AND CRM (99.9%)

(In EURm)	31.12.2022	31.12.2021
Incremental Risk Charge (99.9%)		
Period start	67	101
Maximum value	114	205
Average value	71	116
Minimum value	50	51
Period end	53	67
Comprehensive Risk Measure (99.9%)		
Period start	41	66
Maximum value	133	102
Average value	51	64
Minimum value	39	40
Period end	42	57

9.4 RISK-WEIGHTED ASSETS AND CAPITAL REQUIREMENTS

Allocation of exposures in the trading book

The on- and off-balance sheet items must be allocated to one of the two portfolios defined by prudential regulations: the banking book or the trading book.

The banking book is defined by elimination: all on- and off-balance sheet items not included in the trading book are included by default in the banking book.

The trading book consists of all positions in financial instruments and commodities held by an institution either for trading purposes or in order to hedge other positions in the trading book. The trading interest is documented as part of the traders' mandates.

The prudential classification of instruments and positions is governed as follows:

- the Finance Department's prudential regulation experts are responsible for translating the regulations into procedures, together with the Risk Department for procedures related to holding period and liquidity. They also analyse specific cases and exceptions. They share these procedures to the business lines;
- the business lines comply with these procedures. In particular, they document the trading interest of the positions taken by traders;
- the Finance and Risk Departments are in charge of the control framework.

The following controls are implemented in order to ensure that activities are managed in accordance with their prudential classification:

- new product process: any new product or activity is subject to an approval process that covers its prudential classification and regulatory capital treatment for transactions subject to validation;
- holding period: the Market Risk Department has designed a control framework for the holding period of certain instruments;
- liquidity: on a case-by-case basis or on demand, the Market Risk Department performs liquidity controls based on certain criteria (negotiability/transferability, bid/ask size, market volumes, etc.);
- strict process for any change in prudential classification, involving the business line and the Finance and Risk Divisions;
- internal audit: through its various periodic assignments, Internal Audit verifies or questions the consistency of the prudential classification with policies/procedures as well as the suitability of the prudential treatment in light of existing regulations.

Quantitative information

Around 85% of Societe Generale capital requirements related to market risk are determined using an internal model approach. The standard approach is mainly used for the Collective Investment Units (CIU), for securitisation positions, but also for the positions presenting a foreign exchange risk, which are not part of the trading book, as well as for the Group's subsidiaries that do not have access to the core IT tools developed internally. The main entities concerned are some International Retail Banking and Financial Services entities such as SG Maroc, BRD, SG Tunisie, SG Algérie, SG Côte d'Ivoire, etc.

Capital requirements for market risk increased in 2022. This increase is reflected in the VaR and the risks calculated under the standard approach:

- the VaR gradually increased over 2022, from a historically low level at the end of 2021. This increase is reflected in all activities, notably credit and interest rates;
- risks calculated under the standard approach are on the rise, mainly due to the currency portion. This increase is partially offset by a reduction in the securitization positions of the trading book.

TABLE 91: MARKET RISK CAPITAL REQUIREMENTS AND RWA BY RISK FACTOR

	Risk-weighted assets			Capital requirement		
(In EURm)	**31.12.2022**	**31.12.2021**	***Change***	**31.12.2022**	**31.12.2021**	***Change***
VaR	3,504	1,343	2,160	280	107	173
Stressed VaR	6,886	7,227	(340)	551	578	(27)
Incremental Risk Charge (IRC)	811	840	(29)	65	67	(2)
Correlation portfolio (CRM)	615	815	(200)	49	65	(16)
Total market risk assessed by internal model	**11,816**	**10,225**	**1,591**	**945**	**818**	**127**
Specific risk related to securitisation positions in the trading portfolio	150	562	(412)	12	45	(33)
Risk assessed for currency positions	987	-	987	79	-	79
Risks assessed for interest rates (excl. securitisation)	421	285	136	34	23	11
Risk assessed for ownership positions	374	572	(199)	30	46	(16)
Risk assessed for commodities	0	0	0	0	0	0
Total market risk assessed by standard approach	**1,932**	**1,419**	**513**	**155**	**114**	**41**
TOTAL	**13,747**	**11,643**	**2,104**	**1,100**	**931**	**168**

TABLE 92: MARKET RISK CAPITAL REQUIREMENTS AND RWA BY TYPE OF RISK

	Risk-weighted assets		Capital requirement	
(In EURm)	**31.12.2022**	**31.12.2021**	**31.12.2022**	**31.12.2021**
Risk assessed for currency positions	1,336	349	107	28
Risk assessed for credit (excl. deductions)	3,816	3,984	305	319
Risk assessed for commodities	24	39	2	3
Risk assessed for ownership positions	5,403	4,474	432	358
Risk assessed for interest rates	3,168	2,797	253	224
TOTAL	**13,747**	**11,643**	**1,100**	**931**

9.5 FINANCIAL INSTRUMENTS VALUATION

Management risk related to the valuation of financial products relies jointly on the Markets Department and the team of valuation experts (Valuation Group) within the Finance Department that both embody the first line of defence and by the team of independent review of valuation methodologies within the Market Risk Department.

Governance

Governance on valuation topics is enforced through three valuation Committees, both attended by representatives of the Global Markets Division, the Market Risk Department and the Finance Division:

- the Valuation Risk Committee meets at least once a year to monitor and approve changes in the valuation risk management framework; monitor indicators on this risk and propose or set a risk appetite; evaluate the control system and the progress of recommendations; and finally, prioritize the tasks. This Committee is chaired by the Risk Department and organized by its independent review team of valuation methodologies;
- the Valuation Methodology Committee gathers whenever necessary, at least every quarter, to approve financial products valuation methodologies. This Committee, chaired by the Risk Department and organized by its independent review team of valuation methodologies, has global accountability with respect to the approval of the valuation policies;
- the MARK P&L Explanation Committee monthly analyses the main sources of economic P&L as well as changes in reserves and other accounting valuation adjustments. The analytical review of adjustments is carried out by the Valuation Group, which also provides a quarterly analytical review of adjustments under regulatory requirements for prudent valuation.

Lastly, a corpus of documents describes the valuation governance and specify the breakdown of responsibilities between the stakeholders.

Valuation principles and associated controls

Market products at fair value are marked to market, when such market prices exist; otherwise, they are valued using parameter-based models, in compliance with the IFRS 13 principles defining fair value.

On the one hand, each model designed by the front office is subject to independent validation by the Market Risks Department as second line of defence that especially checks the conceptual relevance of the model, its performance (especially in case of stressed conditions) and its implementation in systems. Following this review, the validation status of the model, its scope of use and the recommendations to be dealt with are formalised in a report.

On the other hand, the parameters used in the valuation models, whether they come from observable data on the markets or not, are described in marking policies[1] written by the front office and validated by the Market Risk Department. This system is complemented by specific controls carried out by LOD1 (in particular the Independent Price Verification process performed by the Finance Department).

If necessary the resulting valuations are supplemented by reserves or adjustments (mainly covering liquidity, parameter or model uncertainties) the calculation methodologies of which are developed jointly by the Valuation Group and the front office and reviewed by the Market Risk Department. These adjustments are made under fair value accounting requirements or prudent valuation regulatory requirements. The latter aim to capture valuation uncertainty in accordance with the procedures prescribed by the regulations through additional valuation adjustments in relation to the fair value (Additional Valuation Adjustments or AVA) directly deducted from Common Equity Tier 1 capital.

(1) Document describing the parameter determination methodology.

9.6 ADDITIONAL QUANTITATIVE INFORMATION ON MARKET RISK

TABLE 93: MARKET RISK UNDER THE STANDARDISED APPROACH (MR1)

	Risk-weighted assets	
(In EURm)	31.12.2022	31.12.2021
Outright products		
Interest rate risk (general and specific)	421	731
Equity risk (general and specific)	374	122
Foreign exchange risk	987	-
Commodity risk	0	0
Options		
Simplified approach	-	-
Delta-plus method		5
Scenario approach	-	-
Securitisation (specific risk)	**150**	**562**
TOTAL	**1,932**	**1,419**

Outright products refer to positions in products that are not optional.

TABLE 94: MARKET RISK UNDER THE INTERNAL MODEL APPROACH (MR2-A)

		Risk-weighted assets		Capital requirements	
(In EURm)		31.12.2022	31.12.2021	31.12.2022	31.12.2021
1	**VaR (higher of values a and b)**	**3,504**	**1,343**	**280**	**107**
(a)	Previous day's VaR (Article 365(1) (VaRt-1))			75	23
(b)	Average of the daily VaR (Article 365(1)) on each of the preceding sixty business days (VaRavg) x multiplication factor ((mc) in accordance with Article 366)			280	107
2	**SVaR (higher of values a and b)**	**6,886**	**7,227**	**551**	**578**
(a)	Latest SVaR (Article 365(2) (SVaRt-1))			145	227
(b)	Average of the SVaR (Article 365(2) during the preceding sixty business days (SVaRavg) x multiplication factor (ms) (Article 366)			551	578
3	**Incremental risk charge – IRC (higher of values a and b)**	**811**	**840**	**65**	**67**
(a)	Most recent IRC value (incremental default and migration risks section 3 calculated in accordance with Section 3 articles 370/371)			53	67
(b)	Average of the IRC number over the preceding 12 weeks			65	66
4	**Comprehensive Risk Measure – CRM (higher of values a, b and c)**	**615**	**815**	**49**	**65**
(a)	Most recent risk number for the correlation trading portfolio (article 377)			42	40
(b)	Average of the risk number for the correlation trading portfolio over the preceding 12-weeks			49	65
(c)	8% of the own funds requirement in SA on most recent risk number for the correlation trading portfolio (Article 338(4))			46	57
5	**Other**	**-**	**-**	**-**	**-**
6	**TOTAL**	**11,816**	**10,225**	**945**	**818**

TABLE 95: INTERNAL MODEL APPROACH VALUES FOR TRADING PORTFOLIOS (MR3)

(In EURm)	31.12.2022	31.12.2021
VaR (10 days, 99%)[1]		
Maximum value	95	98
Average value	56	49
Minimum value	22	18
Period end	75	25
Stressed VaR (10 days, 99%)[1]		
Maximum value	165	191
Average value	101	117
Minimum value	55	72
Period end	145	108
Incremental Risk Charge (99.9%)		
Maximum value	114	205
Average value	71	116
Minimum value	50	51
Period end	53	67
Comprehensive Risk capital charge (99.9%)		
Maximum value	133	102
Average value	51	64
Minimum value	39	40
Period end	42	57

(1) On the perimeter for which the capital requirements are assessed by internal model.

TABLE 96: RWA FLOW STATEMENT OF MARKET RISK EXPOSURES UNDER THE INTERNAL MODEL APPROACH (MR2-B)

(In EURm)	VaR	SVaR	IRC	CRM	Other	Total RWA	Total own funds requirements
RWA at end of previous reporting period (30.09.2022)	**3,308**	**7,789**	**971**	**728**	**-**	**12,796**	**1,024**
Regulatory adjustment	*(2,363)*	*(6,294)*	*-*	*(62)*	*-*	*(8,719)*	*(697)*
RWA at the previous quarter-end (end of the day)	*945*	*1,496*	*971*	*666*	*-*	*4,078*	*326*
Movement in risk levels	(472)	(662)	(307)	(145)	-	(1,585)	(127)
Model updates/changes	455	964	-	-		1,420	114
Methodology and policy						-	-
Acquisitions and disposals						-	-
Foreign exchange movements	8	10				18	1
Other						-	-
RWA at the end of the disclosure period (end of the day)	*936*	*1,808*	*665*	*521*	*-*	*3,930*	*314*
Regulatory adjustment	*2,567*	*5,078*	*147*	*94*	*-*	*7,885*	*631*
RWA at end of reporting period (31.12.2022)	**3,504**	**6,886**	**811**	**615**	**-**	**11,816**	**945**

Effects are defined as follows:

- regulatory adjustment: difference between RWA used for the purpose of regulatory RWA calculation on the one hand and RWA of the last day or of the last week of the period on the other hand;
- movement in risk levels: changes due to position changes;
- model updates/changes: significant updates to the model to reflect recent experience (*e.g.* recalibration), as well as significant changes in model scope;
- methodology and policy: methodology changes to the calculations driven by regulatory policy changes;
- acquisitions and disposals: modifications due to acquisition or disposal of business/product lines or entities;
- foreign exchange movements: changes arising from foreign currency fluctuations.