An assessment of the Fundamental Review of the Trading Book:

The capital requirement impact on a stylised financial portfolio

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Abstract

This paper assesses the impact on capital requirements of the Fundamental Review of the Trading Book (FRTB) based on a stylised financial portfolio sensible to the risk factors affected by the review. Our results show the order of magnitude of the increase across the two regulations and the two possible approaches: the standard approach and the internal model approach. We further disentangle the components of the expected increase implied by the FRTB. The most interesting result emerges for the internal model approach, whereby the increase in the capital charge is attributable not only to the change in the risk measure and the inclusion of longer liquidity horizons, but most importantly to the dampening of the diversification benefit.

Keywords: fundamental review of the trading book; capital requirements; trading portfolio; VaR; stressed VaR; expected shortfall; liquidity risk; bank regulation; Basel Committee on Banking Supervision

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1. Introduction

The Great Financial Crisis of 2007–2009 triggered a revision of bank capital regulations, and the Basel Committee on Banking Supervision (BCBS) reacted with a series of reforms to the so-called Basel II regulations. Specifically, in 2011, the first reform to the market risk framework, known as Basel 2.5, was published (BCBS, 2011a). However, this reform immediately appeared insufficient to ensure bank resiliency from a market risk perspective, and the Committee issued a series of three consultative documents (BCBS, 2012, 2013, 2014b), which proposed a new set of capital rules known as the Fundamental Review of the Trading Book (FRTB). A comprehensive version of these rules was published in January 2016 (BCBS, 2016). After further consultation in 2018, the final FRTB document was published in 2019 (BCBS, 2019) and is to be enforced in 2022. The new market risk framework formalises five main enhancements. For the internal models approach (IMA), the revision provides, first, a more rigorous model approval process (specifically a profit and loss attribution test) and, second, a shift from the Value-at-Risk (VaR) to Expected Shortfall (ES) measure of risk under stress. The latter helps to ensure that "tail risk" is captured and capital adequacy is maintained during periods of significant financial market stress. Third, for the standardised approach (SA), the revision makes this approach sufficiently risk-sensitive to serve as a credible fall-back to the IMA and an appropriate standard for banks that do not require a sophisticated treatment for market risk. A fourth area concerns the incorporation of the risk of market illiquidity, because different liquidity horizons are incorporated into the revised SA and IMA to mitigate liquidity risk across asset markets. These replace the static 10-day horizon assumed for all traded instruments under VaR in the current framework. Finally, a more objective boundary between the trading book and banking book is introduced in order to reduce regulatory arbitrage between them.

The aim of this paper is to provide an assessment, both from the SA and IMA perspectives, of the impact in term of capital requirements against market risk of the final version of the FRTB (BCBS, 2019), with respect to the current regulations (BCBS, 2011a). Given that realistic trading portfolios differ according to the characteristics of each bank, we do not aim for a precise quantitative measurement. Our analysis has two main objectives: first, to gauge the order of magnitude of the increase across the two regulations and the two approaches; and, second, to disentangle the expected increase implied by the FRTB among its main effects, with special attention to the IMA approach. To this end, we consider a stylised financial portfolio sensible to the risk factors impacted by the review, and we compare capital requirements across the two regulations and the two approaches. Because the existing literature on this topic is based on proprietary data and/or provides average results, we believe that our paper adds to the literature because it offers an analysis that is based on publicly available data whilst at the same time capturing the risk factors affecting a real portfolio and disentangling the effects of the reform into its three main components relevant to the IMA: the risk measure change, the change to liquidity horizons, and the reduction in the diversification benefit.

To this end, the paper is structured as follows. Section 2 synthetically reviews the main features of the FRTB under the two approaches (SA and IMA). Section 3 presents a review of literature on the introduction of the FRTB and its impact on banks' capital. Section 4 describes the portfolio and the dataset used in this study, and Sections 5 and 6 present the results. Specifically, Section 5 illustrates the capital requirements under the new regulations for SA and IMA, and Section 6 provides a comparison across the two regulations. The final section concludes the paper.

2. The capital requirement under the FRTB

In order to describe the impact of the FRTB on capital charges, in this section we briefly recall the main changes introduced by the FRTB. We refer to BCBS (2019) for details of the new rules. For the SA, the capital charge results from the sum of three main components: the sensitivities-based method (SbM), the default risk charge (DRC) and the residual risk add-on (RRAO). The SbM is the main and most complex component, calculated by aggregating three risk measures: delta, based on sensitivities of a bank's trading book to regulatory delta risk factors; vega, based on sensitivities to regulatory vega risk factors; and curvature, which captures the incremental risk not captured by the delta risk of price changes in the value of an option. The DRC captures the jump-to-default risk for the whole trading portfolio. The RRAO accounts for market risks not captured in the SA. For banks adopting IMA, the main changes are as follows.

• Risk metrics: the current sum of 1% VaR and stressed 1%VaR (s-VaR) over 12 months of significant losses is to be replaced by 97.5% ES calibrated over a 12 months stress period.

• Liquidity horizons: the current VaR based requirements are based on a 10-day horizon only, whereas ES is to be adjusted on the basis of asset-specific liquidity horizons, which differ according to the types of risk factors that impact the portfolio.

• Limits to benefits from diversification: whereas VaR is currently calculated at the portfolio level, ES is calculated on sub-sets of risk factors as well. In order to limit the "benefits of diversification", the capital charge is calculated as an average of the "diversifiable" and "non-diversifiable" ES.

• Risk of default: except for securitisations, the principles of Basel 2.5 have been preserved, but the incremental risk charge (IRC) has been replaced by a default risk charge (DRC). The DRC excludes migration risk but introduces a lower bound for probability of default and extends its application to equity.

2.1 Standardised approach

In this section, we provide some explanations on the three components of the SA. We refer to BCBS (2019) for a complete and detailed description. The SbM is calculated by aggregating three risk sensitivities: delta, vega and curvature. Curvature captures the incremental risk not captured by the delta risk of price changes in the value of an option. Delta, vega and curvature can be seen as three of the "Greeks" of options (delta, vega and gamma, respectively).

The delta and the vega measures are calculated following the same steps and the same aggregation formula. Each risk measure is estimated according to each risk factor, which must be mapped into seven macro classes selected by the regulator: the general interest rate risk (GIRR), the credit spread risk (CSR) for non securitised exposures, the CSR for securitised exposures in the correlation trading portfolio, the CSR for securitised exposures out of the correlation trading portfolio, the equity risk, the commodity risk and the foreign exchange risk. Moreover, each sensitivity (e.g. delta GIRR, delta CSR, delta equity) is further composed according to so-called buckets; for example, for delta GIRR each currency is a bucket, for delta equity buckets are defined according to size and sector (see Table 9 of BCBS, 2019, p.46).

Once the sensitivities s_k are estimated for each risk factor k, they are weighted using weights RW_k, provided by the regulator to obtain the weighted sensitivity WS_k:

$$WS_k = RW_k s_k.$$

The weighted sensitivities thus obtained for each risk factor k, are aggregated using the correlations ρ_{kl} for risk factors k and l defined by the regulator to the risk position for each bucket, K_b:[1]

$$K_b = \sqrt{\sum_k WS_k^2 + \sum_k \sum_{k \neq l} \rho_{kl} WS_k WS_l}.$$

The final aggregation is across *buckets*, using the buckets' correlations γ_{bc} provided by the regulator to obtain the risk charge:

$$Risk\ Charge = \sqrt{\sum_b K_b^2 + \sum_b \sum_{c \neq b} \gamma_{bc} S_b S_c}\ ,$$

where $S_b = \Sigma_k WS_k$ and $S_c = \Sigma_k WS_k$ for all risk factors in bucket b and c respectively.[2]

The computation of the curvature component follows a different procedure, requiring the application of two stress scenarios corresponding to a positive and a negative shock. Once the net curvature sensitivity of instruments for each risk factor is calculated, for each risk factor the two shocks are applied and the relative variation in the instrument value is calculated. The highest loss is taken as the risk charge. Then the curvature risk exposures are aggregated for each bucket using correlation indexes defined by the regulator. The final charge for curvature risk is obtained by aggregation over buckets. To account for the risk that correlations may increase or decrease in periods of financial stress, three risk charge figures must be calculated for each risk class based on three different scenarios in which correlation indexes are multiplied by 1.25, 1 and 0.75 to represent high, median and low correlation respectively.

2.2 The internal model approach

The FRTB substantially changes the calculation of capital requirements, introducing three main innovations: i) the metrics used for calculation are changed from 99% VaR to 97.5% ES; ii) the time horizon considered is changed from the standard 10-day horizon to different horizons corresponding to the liquidity of asset classes; iii) diversification benefits are dampened by adopting the average of diversifiable and non-diversifiable ES.

The FRTB does not impose any specific model to estimate ES, similarly to the treatment of VaR estimation under the current regulations. For the time horizon. the innovation is actually two-fold: whereas under the current regulations the 10-day ahead VaR can be computed using the one-day ahead VaR scaled by the square root of time rule, the FRTB explicitly stipulates the use of 10-day variations in building the profit and loss (P&L) distribution. A square root adjustment is then applied to account for longer liquidity horizons, as defined in the BCBS document (see Table 2 of BCBS, 2019, p.92), which also provides the following formula for the regulatory ES:

$$ES = \sqrt{(ES_{10})^2 + \sum_{j \geq 2}\left(ES_{10}(j)\sqrt{\frac{LH_j - LH_{j-1}}{10}}\right)^2} \qquad (1)$$

where:

ES_{10} = portfolio expected shortfall over a 10-day horizon;

LH_j = liquidity horizon for risk factors in class j (as defined in Table 1 of BCBS, 2019, p.90);

$ES_{10}(j)$ = expected shortfall computed with respect to shocks in the risk factors with the liquidity horizon at least as long as LH_j only (with the other risk factors constant).

The ES in (1) must be calibrated over a 12-month stress period, which is to be selected from a longer horizon according to the largest portfolio losses.[3] In choosing the stress period, banks are allowed to use a reduced set of risk factors; to account for this, the FRTB applies a further correction to (1), but which has no impact if all the risk factors are considered. In addition to the global portfolio ES (henceforth diversifiable ES), banks must also calculate partial ES for each class of risk factors, which are summed to calculate a non-diversifiable ES. The rationale is, in a conservative perspective, to partially neglect benefits deriving from diversification. The capital charge is then defined as the average of diversifiable and non-diversifiable ES. An adjustment for non-modellable risk factors is added to the ES defined above. As under the current regulations, the final capital charge is the highest of the current measures and the average measure for the last 60 days.[4] A default risk charge (DRC) must also be estimated, based on a VaR model, to account for potential losses deriving from an obligor's default. The DRC is again added to the above-defined charge to obtain the global capital requirement.

3. Literature review

The forthcoming implementation of the FRTB has fostered a debate among academics, consultants and, more generally, the banking industry. Many papers discuss the consequences of the introduction of the FRTB from a theoretical point of view. For example, Farag (2017) illustrates the various aspects of the FRTB and tries to give a quantification of the expected impact on capital and Farag (2018) highlights several critical points in the new framework. Ordgeldinger (2017) adopts a similar approach. Masera (2016) and Magnus et al. (2017) frame the discussion in the context of a general upgrade from Basel III to Basel IV.

Numerical assessments mainly come from the industry, where some authors (e.g. Gnutti, 2016) propose analyses based on proprietary portfolios, highlighting a general increase of capital charges as a consequence of the implementation of the FRTB. Several authors focus on the impact on specific financial instruments. For example, with a focus on commodities exposures, Rossignolo (2020) analyses the new regulations and finds a substantial rise in capital levels for SA and IMA, introducing a solution to level SA and IMA and to provide substantial protection against large market slumps. Lauritzen (2020) analyses the variation in the SA capital charge for mortgage backed bullet bonds. A document by Deloitte (2018) analyses a portfolio of barrier reverse convertibles; whereas under SA, they find a significant increase in the capital charge, under IMA, numbers are comparable.

The most complete analysis on the impact of the new market risk capital standard is presented in the BCBS documents, which are however based on voluntary and confidential data submissions by banks. First, in BCBS (2014a) data are collected from 41 banks on 35 hypothetical portfolios. The first 28 portfolios are defined by asset classes, while the last seven portfolios are mixed. The analysis refers to the IMA, and its main focus is on the variability of the new risk measures compared to the current measures. The conclusion is that the new regulations are not likely to increase variability. Synthetic results comparing the full capital requirement under the new and current regulations are presented across portfolios. The outcome for the average bank is an increase of 80% for the mixed portfolio.[5] The increase characterises all portfolios except equity ones. However, the portfolios were "specifically designed to test variability" (BCBS, 2014a) and therefore additional analysis is required to measure the impact of the new rules. Moreover, the study is based on the initially proposed framework, which was subsequently modified.[6]

An interim impact analysis offered by BCBS (2015) presents a second assessment of the impact on capital requirements of the FRTB that is based on banks' actual portfolios and accounts for both the IMA and the SA approaches. Using a sample of 44 banks, the capital requirements under the new IMA were on average 54% higher than under the current IMA, whereas under the new SA the requirements were on average 128% higher than under the current SA. Based on a sample of only nine banks that provided complete data on both the revised SA and IMA, capital requirements under the SA is two to three times higher than the IMA. For a subset of 36 banks, the change in capital charge under IMA is decomposed by asset class. Although there is an increase for all asset classes, the strongest increase is found for credit spread. The dispersion is very high, however. For the SA, the decomposition is only partial, and the foreign exchange component is found to have the most relevant increase. It must be stressed that the report refers to a review of the consultative documents (BCBC, 2012, 2013) and the comparison was with respect to the market risk capital framework in BCBS (2009a, b). Moreover, the results presented in the report are based on parameter values set at the time the quantitative impact study was undertaken, and "It does not reflect any subsequent revisions to either the internal model-based approach or standardised approach" (BCBS, 2015, p.3). The subsequent impact studies account for the new rules without publishing details. Starting from October 2019, the impact of the finalised FRTB (as published in January 2019) is reflected in the BCBS semi-annual monitoring reports. The synthetic average ratio of the market risk capital requirement under the FRTB and that under the Basel 2.5 standard are reported without distinctions among the various risk components. Despite an overall increase in the capital requirement, the amount of the increase is quite unstable over time and across banks. The wide dispersion in the results calls for further analyses, as emphasised by Farag (2017), and the debate about the impact of the FRTB is ongoing, as stressed by Tunstead (2019). Moreover, the information contained in the semi-annual report are highly synthetic and do not allow a full understanding of the different sources of risk.

Against this backdrop, we believe that further work is needed to fully appreciate the impact of the FRTB on capital charges, and the analyses proposed in this paper advance understanding of the risk factors that are more likely to contribute to an increase in capital charges and disentangle the different components, particularly for the IMA.

4. The portfolio and dataset

To highlight the main channels of the impact of the FRTB on capital requirements, we set up a portfolio which is stylised and yet appropriate to capture the typical risk factors of a trading portfolio (interest rate, credit spread, equity and foreign exchange) and the associated liquidity horizon required by the new regulation. Specifically, in order to identify the effects of the change in the regulations, the portfolio must include risk factors whose liquidity horizons go beyond the 10-day horizon that characterises the current regulations. Furthermore, the portfolio we use allows us to capture the sensitivities introduced by the new SA. Specifically, assuming the viewpoint of a euro-centred bank, we take:

a) a high yield bond position, which is sensitive to both interest rate and credit spread risk;

b) two equity positions, highly representative of the Italian equity market;

c) an at the money index option, which is sensitive to equity prices and volatility; and

d) a foreign currency cash position, which is sensitive to the exchange rate.

Table 1 reports the specific composition of the portfolio and its value.[7] We use Bloomberg as our data provider, taking 2 October 2018 as the reference date from which we estimate all relevant risk metrics for both the SA and IMA, and the period from December 2007 to December 2008 as the stress period for the sVar and ES estimates of the IMA.

Table 1 Portfolio composition and value

Asset	Description	Position	Current value (€)	Portfolio weight
Bond Intesa Sanpaolo	Nominal value: 50,000€, Coupon 5%, Maturity: 23/09/2019, Rating: BB+	18	929,457	50.48%
Equity Eni	Unitary price: 16,34€	12,500	204,275	11.09%
Equity Unicredit	Unitary price: 12.43€	16,000	198,816	10.80%
Foreign currency (USD cash)	Exchange rate (EUR/USD): 1.1549	500,000	432,950	23.51%
Call option on FTSE MIB	Moneyness ATM, Maturity: 15/03/2019	30	75,675	4.12%
Total			1,841,173	100.00%

5. Capital requirements under SA and IMA

In this section, we illustrate the calculation of the capital requirements under the newly proposed regulations applying the SA and the IMA in Sections 5.1 and 5.2, respectively, and in Section 5.3 we provide a comparison of the two approaches under the new regulations.[8]

5.1 The capital charge under the SA

In Table 2, we report the capital requirement derived from the application of the proposed SA to the portfolio described in Section 4. The results show that the new SA yields a high capital requirement, which amounts to 38.7% of the portfolio's market value. Within the SbM, the equity risk component emerges as the biggest contributor to the total.

Table 2 Capital requirement components under the new SA

Components	Capital charge	Weights on the full capital requirement	Percentage on portfolio value
GIRR	26,966.20 €	3.78%	1.46%
EQUITY	512,144.74 €	71.88%	27.82%
FOREX	64,942.79 €	9.12%	3.53%
CSR	108,473.82 €	15.22%	5.89%
Total SbM(1)	712,527.55 €		38.7%

(1) SbM: Sensitivities-based Method, equal to the sum of the capital charges for each risk class.

In order to investigate the capital charge in greater detail, in Table 3 we report the decomposition of the equity charge among the three components delta, vega and curvature. The high relevance of the delta component is due to the long positions held by the portfolio without hedging instruments.

Table 3 Decomposition of the equity risk charge

Equity components	Capital charge	Weights on the equity capital charge	Percentage on portfolio value
Delta	468,820.04 €	91.54%	25.46%
Vega	43,324.70 €	8.46%	2.35%
Curvature	-	-	-
Total	512,144.74 €		27.82%

5.2 The capital charge under the IMA

Consistent with the regulations, we select a 12-month period of financial turbulence in order to estimate ES. The stress period, which registers the worst losses of the hypothetical portfolio, is found to be the 252 trading days from 13/12/2007 to 12/12/2008 as expected.

The portfolio P&L distribution, in line with the majority of banks (EBA, 2017), is estimated by historical simulation.[9] Among the advantages of this non-parametric approach (e.g. O'Brien and Szerszen, 2014), the most valuable, above its simplicity, is the absence of distributional hypotheses: the joint distribution of the risk factors, which determines the distribution of the total P&L, is completely driven by historical data. The portfolio considered in this paper is affected by seven risk factors: one-year risk free interest rate, credit spread, FTSE MIB price, FTSE MIB volatility, Eni and Unicredit equity prices, and EUR/USD exchange rate.

Whereas the standard time horizon for both VaR and ES in the current and new regulations is 10 days, under the current regulations daily VaR can be transformed into 10-day VaR using the square root of time rule. In contrast, under the FRTB, the new regulations require a 10-day horizon to be considered in the estimation of ES. Therefore, whereas for VaR estimation a one-day ahead P&L distribution can be considered, for the estimation of ES we need to build a 10-day ahead distribution. It is explicitly permitted to use overlapping observations to build the time series of changes in risk factors (BCBS, 2019, paragraph 33.4).

The portfolio is evaluated over all risk factor variation scenarios, and changes in value are considered. By ordering the hypothetical portfolio value changes, a distribution of the portfolio 10-day P&L is obtained. ES can then be calculated by choosing the desired confidence level: this is the baseline ES. The FRTB then applies a liquidity horizon adjustment to the 10-day ES according to Table 1, as described in Section 2.

In order to understand the impact of the new regulations, we measure the capital requirement for the stylised portfolio described in Section 3 under the FRTB. Before presenting the results, we list and discuss the assumptions used to calculate the capital requirement under the FRTB.

The first assumption, consistent with the simple structure of the portfolio, is that the full set of risk factors coincides with the reduced set: this implies no need for the adjustment mentioned in Section 2.[10] Second, we only have modellable risk factors impacting the portfolio value and therefore the capital add-on for non-modellable risk factors is assumed to be zero. Third, because for our stylised portfolio the ES remains constant, we consider current values only.[11] Our calculations neglect the multipliers (also in BCBS, 2014a, 2015).

In order to determine the full ES-based internally modelled capital charge (IMCC) as reported in Table 4, we need to calculate the average of the diversifiable (unconstrained) ES (i.e. the so-called IMCC(C) in BCBS (2019)) and the non-diversifiable (constrained) ES (i.e. the ES IMCC(Ci) in BCBS (2019)). As described in Section 2.2, the latter is given by the sum of the ES for risk classes (equity, foreign exchange, credit spread and GIRR) and therefore neglects the benefit of diversification. To quantify the benefit of diversification, in Table 4 we present the comparison between constrained and unconstrained ES; as would be expected, the IMCC(C) is lower than IMCC(Ci).

Table 4 Comparison between constrained and unconstrained ES

Risk measure	Capital charge	Percentage on portfolio value
ES, diversifiable IMCC(C)	162,967.21 €	8.85%
ES, non diversifiable IMCC(C_i)	255,773.72 €	13.89%
IMCC = Average ES	209,370.47 €	11.37%

A further analysis, along the lines of Section 5.1, can be performed by decomposing the constrained ES by risk class. From the results, presented in Table 5, the equity class emerges as the most important for our portfolio.

Table 5 Decomposition of constrained ES

Risk class	Instruments	Capital charge	Percentage of portfolio value
ES EQUITY	Equity, Option	176,988.13€	9.61%
ES CSR	Bond	38,407.92 €	2.09%
ES FX	Foreign currency	38,360.84 €	2.08%
ES GIRR	Bond, Option	2,016.83 €	0.11%
IMCC(C_i)		255,773.72 €	13.89%

5.3 Comparison between IMA and SA

From the results presented in Sections 5.1 and 5.2, it is apparent that the IMA capital requirement is much lower than the SA capital requirement. We now focus on a comparison of the two to single out which risk factors drive the results.[12]

Table 6 Comparison between SA and IMA capital charge under FRTB

Approach	Capital charge	Percentage of portfolio value	SA/IMA
SA	712,527.55 €	38.7%	340.3%
IMA	209,370.47 €	11.37%	

The capital charges reported in Table 6 are directly comparable with the results presented in the quantitative impact study in BCBS (2015). In our work, the simple and transparent structure of the stylised portfolio allows us to clearly quantify the impact of the new regulations on single risk factors.

The comparison by risk class reported in Table 7 shows that the standard treatment of the general interest rate risk factor (GIRR) has the biggest relative difference most between the SA and IMA.

Table 7 Comparison between SA and IMA by risk class

Risk class	Capital charge SA (Percentage on portfolio value)	Capital charge IMA (Percentage on portfolio value)	SA/IMA
GIRR	26,966.20 € (1,46%)	2,016.83 € (0,11%)	1337.06%
EQUITY	512,144.74 € (27.82%)	176,988.13 € (9,61%)	289.36%
CSR	108,473.82 € (5.89%)	38,403.91 € (2.08%)	282.45%
FOREX	64,942.79 € (3.53%)	38,360.84 € (2.08%)	169.29%

6. A comparison across regulations and approaches

In this section, capital charges for both SA and IMA under the current regulations (Basel 2.5) are calculated for comparison with those under the FRTB. Specifically, we first compare SA capital charges in Table 8 and then we focus on the IMA case.

Table 8 shows the difference in capital requirements under SA between the current and new regulations. The new total charge is three times the old one, and the most relevant percentage changes are for the GIRR and equity risk classes.

Table 8 Changes in capital charges from current SA to new SA

Risk class	Requirement current regulations	Requirement FRTB	% Change
GIRR	6,506.20 €	26,966.20 €	314.47%
EQUITY	140,169.56 €	512,144.74 €	265.38%
FOREX	34,636.00 €	64,942.79 €	87.5%
CSR	74,356.56 €	108,473.82 €	45.88%
TOTAL	255,668.32 €	712.527.55 €	178.69%

As for the analysis of IMA, we consider three main effects related to substituting ES metrics for VaR, the introduction of liquidity risk and the reduction in the diversification benefit.

A first step in the analysis is to gauge the effect of the change in the metrics required by the FRTB. To this end, we compare the current regulations' measure (VaR) to the new measure (ES) over the same 10-day horizon. The current regulations define the capital charge as the sum of VaR and sVaR. Consistently, sVaR is estimated on the same stress period as ES, whereas VaR is based on the last 12 months (i.e. 03/10/2017–02/10/2018). Because we wish to isolate the effect of the change in the risk measure, we use sVaR for comparison. The results, shown in Tables 9, underscore that the two measures that refer to a stress period (sVaR and ES) require quite different capital charges. Beyond the P&L distribution, the difference is also due to differences in the methodologies used in historical simulation estimates of risk factor changes and the time *scaling* approaches used.[13] In the current regulations, sVaR and VaR are estimated over daily changes and are scaled up to the 10-day horizon using the square root of time rule. In the new regulations, ES is estimated over 10-day changes by means of overlapping periods.[14]

As a second step, we consider the ES adjusted for the different liquidity horizons as in (1). In order to do this, according to (1), different P&L distributions have to be considered to account for the variations of different subsets of risk factors. Table 9 shows the cascade increase in the risk measure when the changes are considered.

Third, we consider the full capital charge under the new regulations, measured as the average of the diversifiable ES (liquidity adjusted ES) and the non-diversifiable ES (sum of the partial ES by risk factor class). As for the current regulations, the capital requirement is obtained as the sum of VaR and sVaR. Table 10 shows the comparison of the full capital charges.

In summary, two main results emerge. First, the capital charge under the new regulations is significantly higher than under the current regulations, consistent with the aim of the BCBS to strengthen the banking system in terms of capital. Second, by comparing Table 9 and Table 10, it can be seen that the new capital charge exceeds the current charge only when the diversification benefit is dampened. In fact, despite the increase induced by the change in the risk measure, the current capital charge would still be higher by fully considering the diversification effect.

Table 9 Comparison of risk metrics

Risk measure	Capital charge	Percentage of portfolio value
sVaR	101,540.00 €	5.51%
10-day ES	144,226.17 €	7.83%
Liquidity-adjusted ES	162,967.21 €	8.85%

Table 10 Capital requirement under current and new IMA

Regulation	Metric	Capital charge	Percentage of portfolio value
Current	VaR+sVaR	180,097.00 €	9.78%
FRTB	IMCC	209,370.47 €	11.37%

7. Conclusions

Before summarizing our main results, it is worth recalling three main objectives of the FRTB regarding the IMA. First, the reform is intended to more fully capture so-called tail risks by substituting VaR-based metrics with the ES. Second, the reform aims to incorporate liquidity risk by introducing liquidity horizons that are differentiated according to the specific risk factor considered. Finally, by introducing constraints on the use of correlations between risk factors, the reform also targets a reduction in the regulatory diversification benefits.

The analysis presented in this paper aims to gauge, both for banks adopting internal and standard models, the impact of the final version of the FRTB with respect to the current regulations. The two main objectives are to gauge the order of magnitude of the increase across the two regulations and the two approaches, and to disentangle the expected increase implied by the FRTB according to its main effects, giving special attention to the IMA approach.

To this end we have proposed an empirical analysis based on a stylised portfolio sensible to the risk factors affecting a real portfolio and most impacted by the review, i.e. equity, volatility, interest rate, credit spread and exchange rate. In contrast to literature on this topic that is based on proprietary data and/or providing average results, our analysis is based on publicly available data and on a clearly defined portfolio.

Three main results emerge from our analysis. First, the newly proposed regulations imply an increase in capital requirements for both SA and IMA. Second, the risk factors that most contribute to the increase in capital charge for the SA are the equity and the interest rate risk factors, whereby the latter is the most penalising factor in the comparison between the SA and IMA. Third, focusing on the IMA, our analysis disentangles the effects of the change in the metrics from VaR to ES, the consideration of longer liquidity horizons and the constraints on the diversification benefit. The increase in the capital charge is attributable not only to the change in the risk measure and the inclusion of longer liquidity horizons, but most importantly to the dampening of the diversification benefit.

Overall, in consideration of the three main objectives of the reform, our results support the conclusions that the strengthening of the capital requirement is indeed achieved under both approaches, but a relevant role is played by the reduction of the diversification benefit.

Our results confirm that the FRTB might have strategic implications for trading books, promoting a change towards core assets that mainly contribute to profitability with a possible repricing of some assets in order to preserve profitability in the presence of a more capital-intensive system and a reduction in holdings of those structured products requiring more capital (Kancharla, 2016).

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Data Availability Statement

Data sharing is not applicable to this article as no new data were created or analysed in this study.

[1] The quantity within the square root is floored to zero.

[2] If the quantity within the square root is negative an alternative specification is given by the regulator (BCBS, 2019).

[3] The observation period must span back to at least 2007.

[4] The average ES is actually multiplied by a factor dependent on the backtest outcome.

[5] This comparison does not account for the multipliers.

[6] For example, the ES was at that stage intended to be calculated according to single risk factor horizons, whereas in the subsequent document the adjustment formula was introduced. Many banks had already applied this simplification at the time of the exercise.

[7] Note that to simplify we have modelled interest rate risk on a single maturity. Moreover, we have not included any commodity position. For the effect of the reform on commodity positions, see Rossignolo (2020).

[8] In our analysis the default risk component is omitted.

[9] An alternative to plain historical simulation is volatility weighted historical simulation (VWHS). Laurent and Omidi Firouzi (2017) discuss the use of this method in relation to the new regulations.

[10] This hypothesis amounts to assuming the adjustment ratio is equal to 1 in BCBS (2019), paragraph 33.6.

[11] The Basel regulations require that for each metric (VaR, sVaR and ES), the value taken must be the highest of the current value and the average of the last 60 days multiplied by a scaling factor, as explained in Section 2.2.

[12] The order of magnitude is partially due to the portfolio analysed because we do not consider hedging positions, which would allow a reduction in the SA capital charge, whereas the SA does not account for diversification.

[13] Under normality of risk factors and portfolio linearity (that is, normality of the P&L distribution), the 99% VaR and the 97.5% ES approximately coincide. When the distribution is fat-tailed, ES exceeds VaR.

[14] The effect of using the scaling approach based on the square root of time is discussed in the literature (e.g. Danielsson and Zigrand, 2006; Wang et al., 2011): the conclusions are not uniform in that they depend on the data features in terms of distribution, volatility clustering, autocorrelation, jumps, etc.