BANCA D'ITALIA

EUROSISTEMA

Mercati, infrastrutture, sistemi di pagamento

(Markets, Infrastructures, Payment Systems)

The use of Banca d'Italia's credit assessment system for Italian non-financial firms within the Eurosystem's collateral framework

by Stefano Di Virgilio, Alessandra Iannamorelli, Francesco Monterisi and Simone Narizzano

June 2025

Number 60

BANCA D'ITALIA
EUROSISTEMA

Mercati, infrastrutture, sistemi di pagamento

(Markets, Infrastructures, Payment Systems)

The use of Banca d'Italia's credit assessment system for Italian non-financial firms within the Eurosystem's collateral framework

by Stefano Di Virgilio, Alessandra Iannamorelli, Francesco Monterisi and Simone Narizzano

Number 60 – June 2025

The papers published in the 'Markets, Infrastructures, Payment Systems' series provide information and analysis on aspects regarding the institutional duties of the Bank of Italy in relation to the monitoring of financial markets and payment systems and the development and management of the corresponding infrastructures in order to foster a better understanding of these issues and stimulate discussion among institutions, economic actors and citizens.

The views expressed in the papers are those of the authors and do not necessarily reflect those of the Bank of Italy.

The series is available online at www.bancaditalia.it.

Printed copies can be requested from the Paolo Baffi Library: richieste.pubblicazioni@bancaditalia.it.

ISSN 2724-6418 (online)
ISSN 2724-640X (print)

Banca d'Italia
Via Nazionale, 91 - 00184 Rome - Italy
+39 06 47921

Designed and printing by the Printing and Publishing Division of the Bank of Italy

THE USE OF BANCA D'ITALIA'S CREDIT ASSESSMENT SYSTEM FOR ITALIAN NON-FINANCIAL FIRMS WITHIN THE EUROSYSTEM'S COLLATERAL FRAMEWORK

by Stefano Di Virgilio, Alessandra Iannamorelli, Francesco Monterisi and Simone Narizzano*

Abstract

Banca d'Italia's In-house Credit Assessment System (BI-ICAS) has been assessing Italian non-financial firms' creditworthiness within the Eurosystem's collateral framework since 2013. BI-ICAS uses a statistical model, which produces monthly one-year probabilities of default (PDs) for around 370,000 firms, combined with expert assessments performed by analysts on a subset of approximately 4,000 companies per year. Italian firms' credit quality, measured by PDs, has gradually improved since 2013; in the years 2020-2022, this improvement was mainly due to policy support measures following the pandemic, and to the subsequent economic recovery. The high costs of debt and the cyclical slowdown have resulted in a slight deterioration in PDs since 2023. Disparities persist by sector, size and region. During the period observed, credit claims became more and more significant among the collateral asset classes used in Eurosystem refinancing operations, eventually becoming the predominant category. In Italy, the use of BI-ICAS assessments has facilitated banks' access to central bank liquidity, particularly during the pandemic. In line with Eurosystem initiatives, Banca d'Italia is committed to integrating climate change-related risks into BI-ICAS assessments, using methodologies that combine quantitative and qualitative assessments to estimate the impact of transition and physical risks.

JEL Classification: G32, G33, C51, C52.

Keywords: Credit Risk, Credit Scoring, Probability of Default, Collateral Framework.

Sintesi

Dal 2013 il sistema interno di valutazione del merito di credito della Banca d'Italia (BI-ICAS) valuta la solvibilità delle imprese italiane non finanziarie nell'ambito del quadro delle garanzie dell'Eurosistema. BI-ICAS utilizza un modello statistico, che produce probabilità di default (PD) a un anno su base mensile per circa 370.000 imprese, per un sottoinsieme delle quali (circa 4.000 l'anno) combinato con il giudizio esperto fornito dagli analisti. Dal 2013 il merito di credito delle imprese italiane, misurato dalle PD, è gradualmente migliorato; nel triennio 2020-2022 vi hanno in particolare contribuito le misure di sostegno introdotte dal governo durante la pandemia e, successivamente, la fase di ripresa economica. Dal 2023 gli elevati costi di finanziamento e il rallentamento ciclico si sono riflessi in un lieve peggioramento. Permangono disparità per settore, dimensione e regione. Nel periodo osservato i crediti hanno visto aumentare il loro peso tra le garanzie utilizzate nelle operazioni di rifinanziamento dell'Eurosistema, fino a diventare la principale categoria. In Italia l'utilizzo delle valutazioni BI-ICAS ha facilitato l'accesso delle banche alla liquidità di banca centrale, in particolare nel periodo della pandemia. In linea con le iniziative dell'Eurosistema, la Banca d'Italia è impegnata a integrare i rischi legati al cambiamento climatico nelle valutazioni BI-ICAS, con metodologie che combinano valutazioni quantitative e qualitative per stimare l'impatto del rischio di transizione e fisico.

* Banca d'Italia, Financial Risk Management Directorate.

CONTENTS

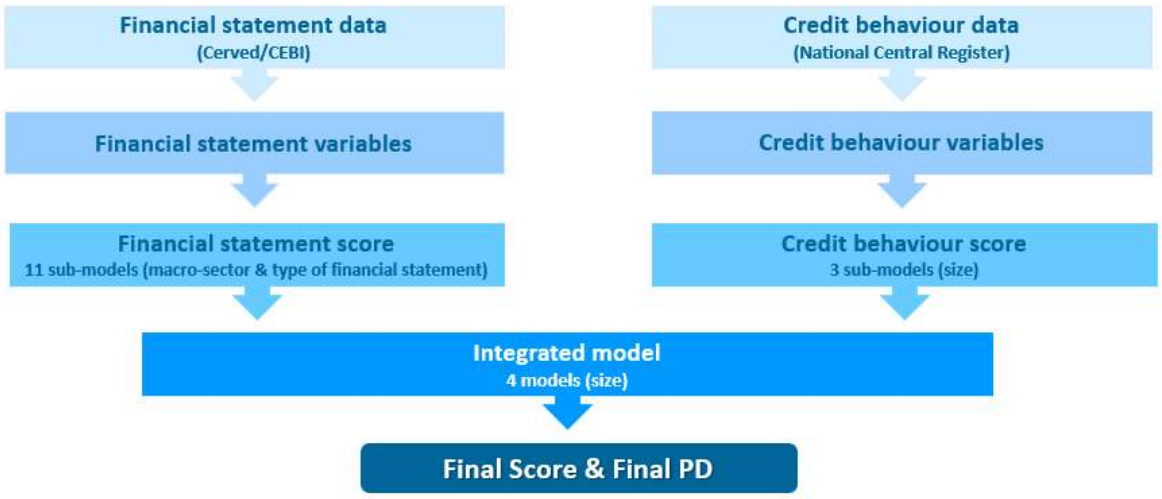
1. Introduction[1]

Since 2013, Banca d'Italia has developed an internal system for the assessment of the creditworthiness of Italian non-financial firms (*In-house Credit Assessment System*, or ICAS). The use of ICAS evaluations allows banks to pledge the loans to the assessed firms as collateral in the Eurosystem monetary policy operations, thus enhancing access to central bank refinancing.[2]

Banca d'Italia's ICAS (BI-ICAS)[3] is composed of a statistical model and, for a subset of firms, of an additional evaluation by financial analysts (the so-called expert assessment), in line with the Eurosystem requirements.

The statistical model is based on a system of logistic regressions that integrates a financial statement score obtained from a set of models and a credit behavioural score obtained from another set of models employing Central Credit Register (CR) data (fig. 1).[4] The system is regularly updated to account directly for the effects of the macroeconomic cycle.

Figure 1 - The ICAS Stat model architecture



The architecture of the statistical model allows for the evaluation of companies' creditworthiness by considering, in the financial statement component, the sectoral characteristics of companies, the type of financial statement (ordinary or simplified), and the size in the CR component. The components are integrated by considering company size.[5]

The statistical model (or ICAS Stat) generates the one-year probability of default (PD) for approximately 370,000 Italian non-financial firms recorded in the CR. ICAS Stat evaluates about 40 per cent of Italian

[1] We thank for useful comments and suggestions an anonymous referee, Francesco Columba, Tommaso Perez and Antonio Scalia.
[2] The *Eurosystem Credit Assessment Framework* (ECAF) foresees also two other systems to assess the creditworthiness of non-financial firms: the banks' internal models (*Internal rating based*, IRB) and the *External Credit Assessment Institutions* (ECAIs). See Auria *et al.* (2021). Within the Eurosystem, also the central banks of Austria, France, Germany, Greece, Portugal and Spain manage an ICAS.
[3] For a thorough description, see Giovannelli *et al.* (2023).
[4] For further details, see Narizzano *et al.* (2024).
[5] As defined by the European Commission 2003/361/EC.

non-financial firms, with a share of 80 per cent in the total revenues of this category of firms. The PDs are updated monthly.

2. The creditworthiness of non-financial firms

ICAS Stat PDs show a gradual improvement of the creditworthiness of Italian firms between 2013 and 2024.[6] In the aftermath of the sovereign debt crisis and up to the COVID-19 pandemic, the PDs significantly decreased in line with the economic recovery and the improvement in firms' financial structure, favoured by the accommodative monetary policy stance (fig. 2, panel a). The sharp decline in the values corresponding to the 75th and 90th percentiles of the sample distribution indicates that the improvement has also affected weaker companies. The deterioration of credit quality following the COVID-19 outbreak prompted the worsening of the financial statement scores (fig. 2, panel b). Such phenomenon was mitigated by the stability of the credit behaviour scores (fig. 2, panel c), that benefited from the Government measures aimed at preserving firms' access to credit (debt moratorium and public guarantee schemes). The effects of the pandemic crisis were heterogeneous across sectors,[7] as a significant increase of the financial statement PDs was observed only near the values corresponding to the 75th and 90th percentiles of the PD distribution, while the median value remained stable (fig. 2, panel b).

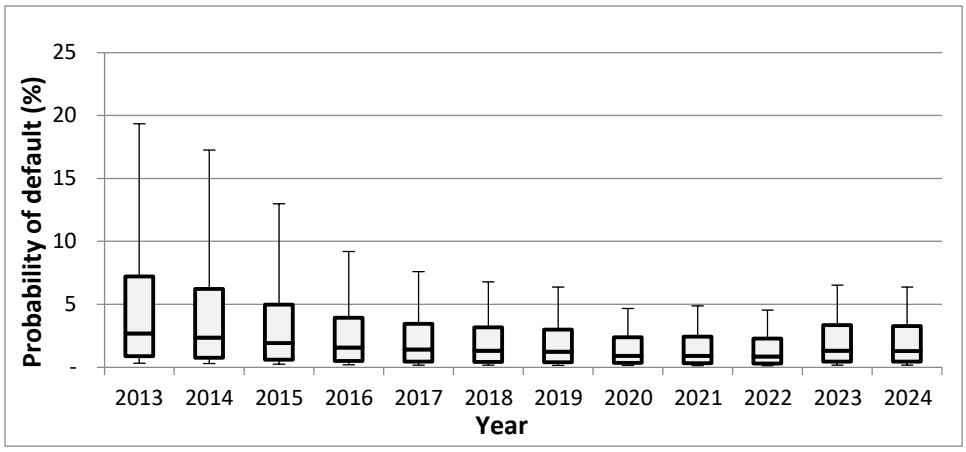
The vigorous post-pandemic economic recovery caused a decline in the PDs at the end of 2022, thanks to a significant improvement in the financial statements for 2021 and the stability of the credit behaviour component. The PDs estimated at the end of 2023 showed a slight deterioration. The mild increase in risk was entirely attributable to the changes in the macroeconomic context, considering the stability of the financial statement and of the credit behaviour components of the model. The slowdown in the domestic economic outlook, the global instability, the effects of persistent inflation and the sharp rise in interest rates were expected to affect companies' ability to meet their debt obligations negatively. At the end of 2024, firms' creditworthiness remained stable compared to the end of 2023. This may be attributed to the joint effect of two factors: on the one hand, high financing costs, inflationary pressure and weak economic growth led to a modest increase of financial statement PDs (based on 2023 financial statements); on the other hand, by the end of 2024 the macroeconomic component of the model slightly improved, benefitting from a gradual easing of borrowing costs and a reduction in inflationary pressures. According to our estimates, the default rate for Italian firms will be around 3 per cent in 2025, driven by still high financing costs, weak economic growth and increased geopolitical risks.

[6] For a broader discussion of credit quality developments in the Italian financial and non-financial sector please refer to Banca d'Italia's Financial Stability Report. Data in this section refer to the evaluations at the end of each year of about 370,000 firms. The most recent PDs are as of the end of 2024, based on contemporaneous CR data and on financial statements mostly for 2023.

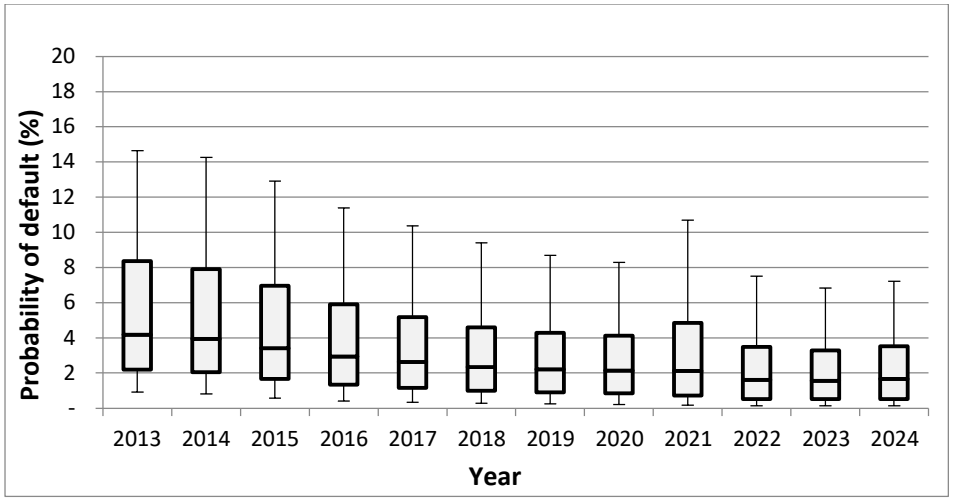
[7] For further details, see De Socio *et al.* (2020).

Figure 2 - Default probability (2013 – 2024)

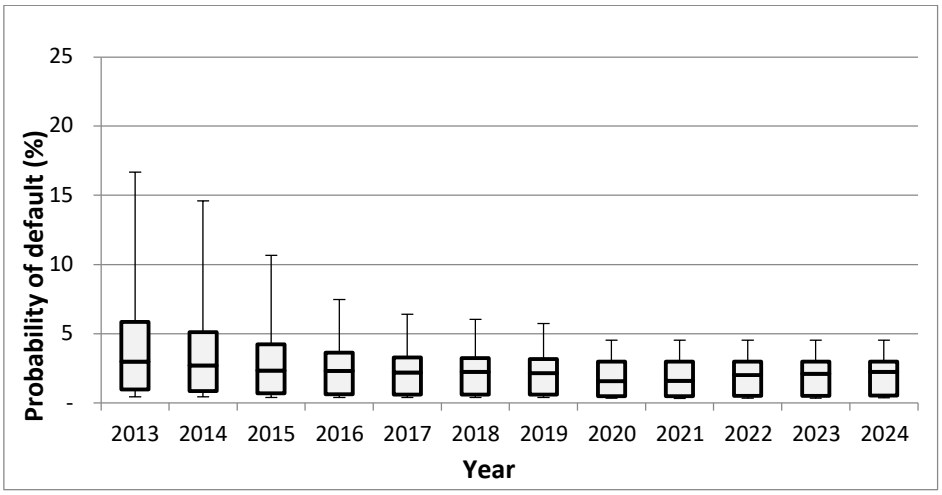
a) PD distribution



b) Financial statement PD distribution



c) Credit behaviour PD distribution



Note: the boxplots mark the 90th, 75th, 50th, 25th and 10th percentiles of the distribution.

The ICAS Stat PDs are categorized into 18 risk classes and mapped into the credit quality steps (CQS) of the Eurosystem harmonized rating scale to compute the haircuts for the bank loans posted as collateral in monetary policy operations (see Appendix A). Each CQS can be associated with a different degree of solvency (table 1).

Table 1 - Credit quality steps

(percentage values)

Credit quality	PD min	PD max
Excellent	0	0.1
Very good	0.1	0.4
Good	0.4	1
Fair	1	1.5
Acceptable	1.5	3
Vulnerable	3	5
Very vulnerable	5	99.99
Default	100	100

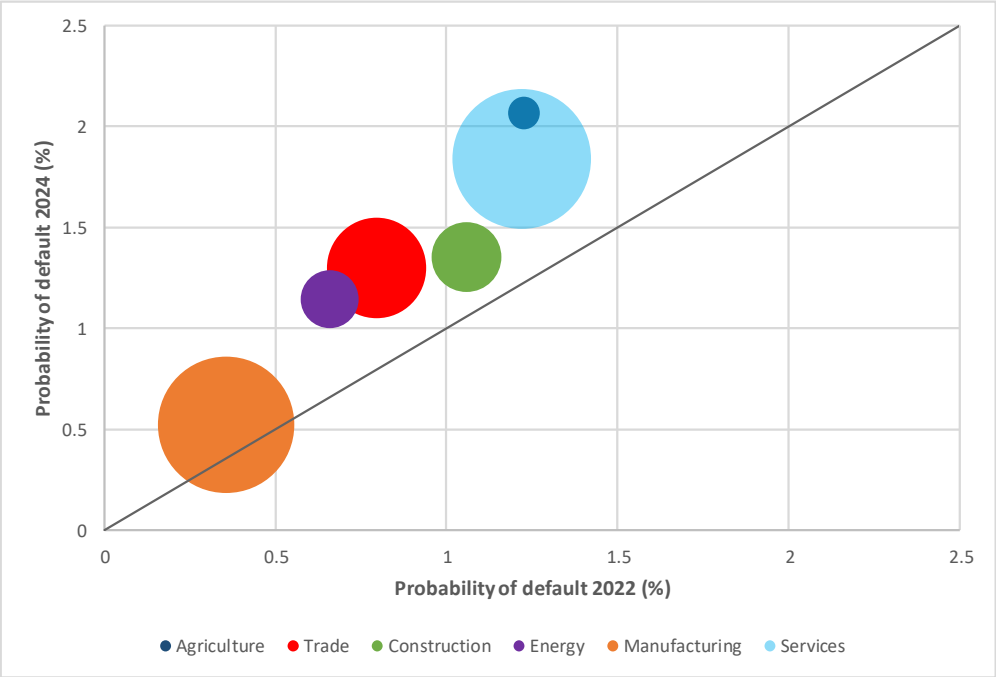
According to the statistical model, compared to 2022,[8] in 2024 Italian firms[9] have migrated towards higher risk classes (fig. 3); however the impact on the median statistical PD has been moderate.

Figure 3 - Distribution of firms by credit quality step (2022 – 2024)

[8] Considering the overall stability of the PDs between 2023 and 2024, in the rest of the document, we present the evolution of PDs in the last two years.
[9] For further details, please refer to the Appendix B.

The manufacturing and energy sectors have proven to be the least risky over 2022-2024. In that period the statistical PDs of Italian firms rose for all sectors; the increase was more pronounced for agriculture and services[10] (fig. 4).

Figure 4 - Median PD by sector (2022 – 2024)



Source: In-house credit assessment system of Banca d'Italia and Central Credit Register.
Note: The size of the bubble corresponds to the amount of loans to firms in each sector at the end of 2024.

Large and medium-sized firms are more creditworthy than small firms and especially micro firms. The higher riskiness of micro enterprises reflects their weaker capital structure (table 2).

Table 2 – Capital structure by size

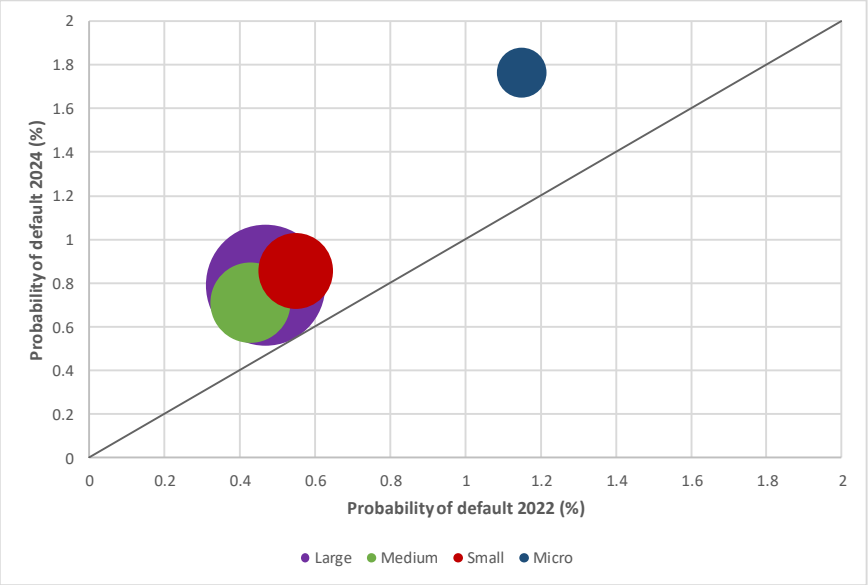
(percentage values)

Size	Equity to total net debt
Micro	38
Small	55
Medium	70
Large	77

[10] For our purposes the services sector also includes real estate.

In the period 2022-2024 the PDs of micro enterprises increased more than those of the other firms (fig. 5). The weaker financial condition of micro firms makes them more prone to the deterioration of the macroeconomic outlook.

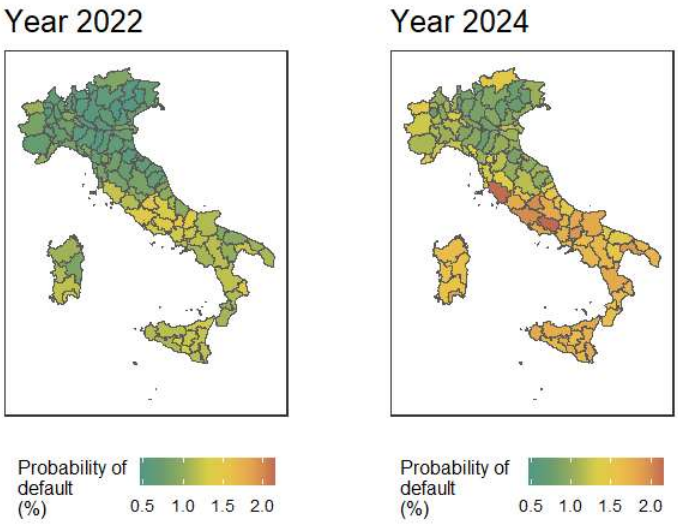
Figure 5 - Median PD by size class (2022 – 2024)



Source: In-house credit assessment system of Banca d'Italia and Central Credit Register.
Note: The size of the bubble corresponds to the amount of loans to firms in each sector at the end of 2024.

In the period 2022-2024, firms' riskiness increased across macro-regions at a different pace. Statistical PDs in the Centre, South, and in the Islands have shown a significant deterioration; the gap with the PDs of firms in the North has widened (fig. 6). This trend in riskiness is consistent with the different distribution of firms among macro-regions. In particular, micro firms account for about 62 per cent of firms in the Centre, South and Islands compared to 52 per cent in the North area. At the end of 2024 the share of firms in the vulnerable and very vulnerable classes was 31 per cent for the Centre and South and 32 per cent for the Islands, compared to 26 per cent and 23 per cent, respectively, for the North-West and North-East areas.

Figure 6 - Median PD by geographical areas (2022-2024)



3. The evolution and the riskiness of bank loans pledged as collateral

The Eurosystem accepts as collateral in monetary policy operations a large set of assets, including marketable debt instruments (public sector securities, corporate bonds, bank bonds, ABS) and bank loans. Bank loans are a significant component of the collateral pledged to the Eurosystem and their use — allowing banks to refinance otherwise illiquid assets — supports the provision of credit to the economy on favourable terms.[11] Starting from the second half of 2020, credit claims constitute the most important asset class as a share of the Eurosystem collateral, accounting for more than 30 per cent of the total value of collateral pledged by euro area banks.[12]

In conducting refinancing operations, the Eurosystem is exposed to banks' default risk and to the risks associated with the collateralized assets. Collateral protects the Eurosystem in credit operations against losses that might affect its financial independence and credibility. Consequently, a robust set of rules has been defined on the financial soundness of counterparties and on the eligibility of collateral,[13,14] including the application of valuation haircuts on the assets pledged as collateral.[15] Haircuts depend on the characteristics of collateral, notably on the credit risk measured by means of the PD estimated with one of the eligible rating sources: ECAIs, IRBs, and ICASes.

In the last decade, the use of BI-ICAS by Italian monetary policy counterparties has significantly increased: the number of banks that use it for evaluating credit claims pledged as collateral was 52 at the end of 2024, with a steady growth over previous years.[16] The amount of collateral evaluated with ICAS has also significantly grown, reaching a peak at the end of 2022 (34.2 billion euros in net terms).

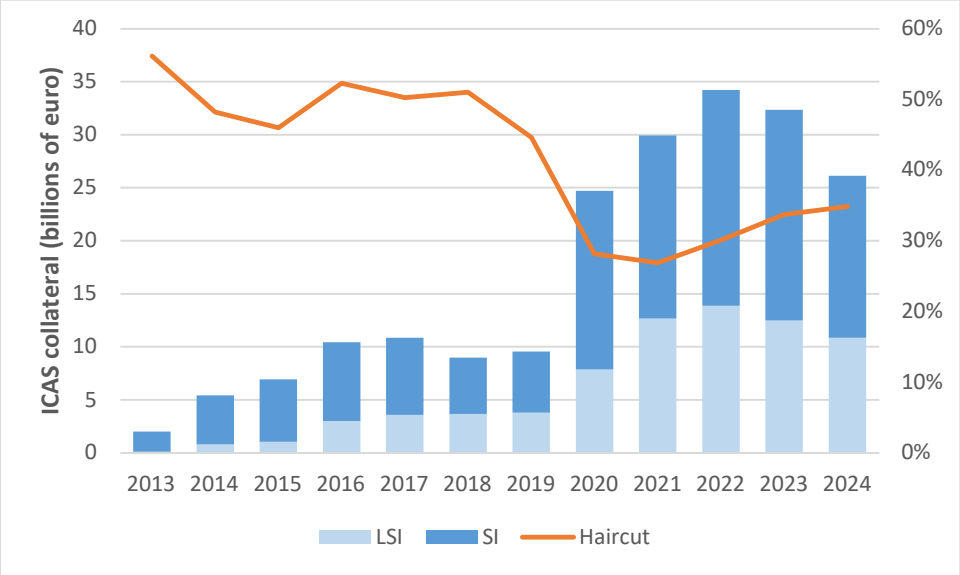
The sharp growth of the loans assessed with ICAS from 2019 to 2022 is related to the introduction by the Eurosystem of extraordinary measures aimed at countering the adverse effects of the pandemic crisis, by easing banks' access to central bank liquidity; in particular, in April 2020 the Eurosystem reduced the haircut applied to all eligible assets (fig. 7).[17] In Italy the so-called Additional Credit Claims Framework was expanded to let counterparties pledge a wider range of loans as collateral in monetary policy operations. The availability of ICAS PDs for a large share of firms contributed to easing banks' access to central bank refinancing. At the end of 2024, as monetary policy normalization was underway, the amount of credit claims evaluated with ICAS decreased, to 26.1 billion euros (fig. 7). The average haircut increased from 30 per cent in 2022 to 35 per cent in 2024.

ICAS evaluations are widely used by both significant banks (SIs) and less significant banks (LSIs). At the end of 2024, the net value of collateral evaluated with ICAS and provided by SIs was 15.3 billion euros

[11] Mésonnier *et al.* (2021).
[12] For more information, please refer to https://www.ecb.europa.eu/mopo/coll/charts/html/index.en.html
[13] European Central Bank, 2015.
[14] To be eligible as collateral all assets must meet certain criteria regarding the type of instrument, place of issuance, currency of denomination, country of residence of the debtor (or guarantor), and credit quality. Based on ordinary rules, bank loans must have an annual PD less than or equal to 0.40 per cent. Besides, the collateral framework has been progressively expanded with the introduction of the Additional Credit Claims (ACC) scheme. This started in December 2011 to facilitate banks' access to monetary policy operations. Under the ACC scheme, individually pledged loans must have an annual PD less than or equal to 1.5 per cent; for loans pledged within a portfolio, an initial PD limit of 10 per cent was set; this was later removed with the subsequent measures on the collateral framework adopted in response to the pandemic. Only performing loans can be accepted as collateral.
[15] Collateral haircuts are prudential deductions applied to the value of pledged assets to calculate the net collateral value. Haircuts are intended to cover potential losses in the value of the assets in the event of counterparty default and during the time required for their sale. The haircut is proportional to the risk level of each asset, thus ensuring that the residual risk is equal for all pledged assets under the so-called risk equivalence principle.
[16] The figure considers also three counterparties that employ only pool of loans to households.
[17] Valuation haircuts for marketable assets were reduced by 20 per cent (on average from 9.1 to 7.3 per cent) and by 42 per cent for non-marketable assets (on average from 44.6 to 25.8 per cent). For further details, see Antilici *et al.* (2023).

(-25 per cent compared to 2022), while LSIs used ICAS evaluations for 10.8 billion euros of loans (-22 per cent compared to 2022; fig. 7). The decrease of net collateral is due to the increase in the average haircut and to the decrease in the gross value of pledged loans.

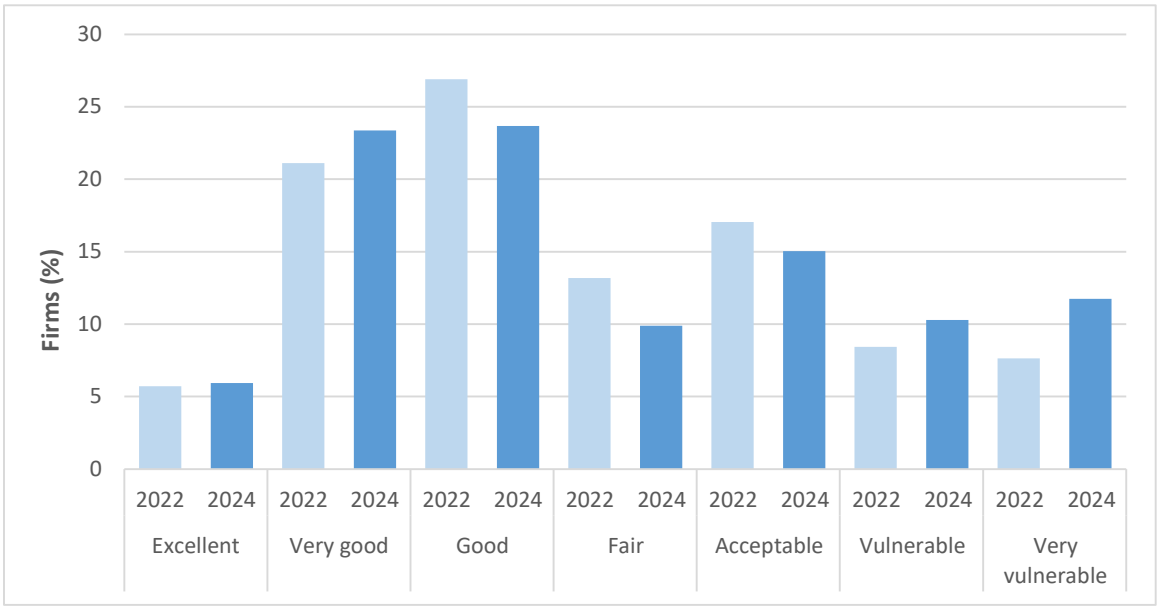
Figure 7 - Bank loans as collateral evaluated with ICAS – Distribution by bank class[18] (left hand scale) and average haircut (right hand scale)



In 2024 credit claims pledged as collateral showed an increase in credit risk: the weighted average PD rose from 2.39 in 2022 to 2.65 per cent. The share of firms in the vulnerable and very vulnerable classes increased from 16 per cent in 2022 to 22 per cent in 2024 (fig. 8); however, it remained lower than the corresponding share in the overall portfolio of firms evaluated by ICAS (28 per cent; fig. 3). The lower credit risk of the portfolio of loans pledged as collateral compared to that of the overall portfolio evaluated with ICAS is related to the risk control rules of the collateral framework that discourage the use of credit claims towards more vulnerable firms.[19]

[18] Net of haircut.
[19] The ECB publishes on its website only the list of marketable assets, updated daily by the National Central Banks (NCBs). The eligibility of bank loans depends on predetermined rules verified by the competent NCB.

Figure 8 - Distribution of firms by credit quality step (credit claims pledged; 2022-2024)



4. Embedding climate change risk into credit risk assessment

The ECB is committed to addressing climate change risk (CCR) within its mandate. With the decision No. 541 of 22 June 2022, the Governing Council outlined its action plan including the integration of CCR into the expert assessment of the ICASes by the end of 2024. Specifically, the ECB requires that CCR analysis meets the same quality and reliability standards as other risk factors and aims at enhancing the coverage of assessed entities with granular data.[20] The requirements concern the data, methodology, and processes to assess transition and physical risks. ICASes must primarily focus on the firms most exposed to these risks and on larger firms that pose more significant risks to the Eurosystem. The methodologies must combine data on risk factors (such as the price trend of high-carbon energy sources), on exposure to risk (greenhouse gas emissions), and on the residual vulnerability of firms after adopting risk mitigation measures (such as technologies aimed at reducing polluting emissions). In the short term, the availability of reliable and comparable data is the main challenge for ICASes and for other credit assessment sources.

The European Union Corporate Sustainable Reporting Directive (CSRD) requires the largest firms to publish sustainability data. These data will be available in the next years. Data produced by specialized providers may mitigate the information gaps about the exposure of individual firms to CCR. BI-ICAS will have to use as the primary data source on CCR the self-disclosed information by firms according to CSRD provisions as soon as they come into force. Meanwhile, the ECB encourages ICASes to obtain firm-level data from other sources, such as the European Union Emissions Trading System (EU-ETS), using sectoral or regional information when firm-level data is unavailable (Körding & Resch, 2022).

Another significant challenge for the ICASes is aligning their one-year forecast horizon with the multi-year horizons envisaged by the Kyoto targets and the scenarios of the Network for Greening the Financial System (NGFS).[21] Currently, ICASes are expected to conduct their assessment in two phases: the first phase of CCR evaluation covers a longer-term horizon; the second phase concerns the materiality of CCR

[20] See Körding & Resch (2022).
[21] The Kyoto Protocol, entered into force on 16 February 2005, is a commitment by industrialized countries and economies in transition to limit and reduce greenhouse gases (GHG) emissions in accordance with agreed individual targets.

on the credit quality of firms. Such sequential approach is crucial to ensure a comprehensive and forward-looking assessment of climate change risks, in line with the Kyoto targets and the NGFS scenarios.

In line with the ECB guidelines, Banca d'Italia is committed to integrating CCR into the BI-ICAS expert assessment. The methodology includes an analysis of transition risk and physical risk. For both risk factors, the approach combines quantitative and qualitative assessments.

The current approach predominantly relies on data obtained from external or sectoral sources; individual data provided by firms in non-financial disclosures (NFD), if available, are used to supplement the analysis. To address the scarcity of granular firm-level data on CCR, initiatives are underway[22] which will be leveraged by BI-ICAS to achieve a more accurate assessment of the impact of CCR on firms' creditworthiness.[23,24]

For transition risk, the starting point for each firm is the PD re-evaluation by means of scenario analysis. The quantitative assessment is supplemented by a qualitative assessment of the firm's transition risk based on information regarding emissions, decarbonization targets, and other elements. Analysts also review available scores from external providers over the past three years. Similarly, for physical risk the analysis starts from the scores obtained from specialized providers concerning the main physical events, such as floods and landslides. This step is followed by a qualitative assessment based on information about the catastrophes that occurred in recent years, insurance coverage, etc. The assessment of transition risk and physical risk are then integrated into an opinion on the impact of CCR, which contributes to the final ICAS rating.

The methodology developed by BI-ICAS to assess the sensitivity to transition risk relies on a microeconomic approach to estimate the firm's energy consumption starting from official sectoral statistics collected from the Physical Energy Flow Accounts (PEFA), National Accounts, and INPS. Similar to Faiella *et al.* (2024), a scenario analysis is performed and enhanced by a microsimulation model. At an aggregate level, the estimated impact of a carbon tax on the creditworthiness of Italian non-financial firms appears limited, but it significantly differs among economic sectors. The most affected sectors are those that depend the most on fossil fuels and those whose energy demand is inelastic to price changes, including transport, fishing, and oil refining.

To address the limitations of sectoral imputation and static NGFS scenarios, BI-ICAS has developed an enhanced methodology using granular data on certified emissions and transactions from EU-ETS participants. Stochastic simulation projects EUA futures price trajectories into the firm balance sheet, incorporating carbon market dynamics through a GJR-GARCH volatility model. The range of scenarios enable to select a baseline and an extreme scenario for assessing the financial impact of carbon pricing.[25]

[22] In Italy the Coordination Table on Sustainable Finance (chaired by the Ministry of Economy and Finance, with participation from Banca d'Italia, Consob, Ivass, the Ministry of Environment and Energy Security, and Covip) facilitates the accessibility and integration of currently available databases on the environmental risks of firms and households. It also seeks to encourage SMEs not subject to CSRD obligations to provide sustainability information voluntarily, harmonized and proportionate to their size, to meet the informational needs of banks, non-financial firms, and investors with whom SMEs have financial or commercial relationships.

[23] Angelini (2023).

[24] In 2024, an experimental survey on a limited number of firms assessed by BI-ICAS was conducted to check the integration of CCR factors within credit assessment with firm-level data.

[25] Under the baseline scenario, costs are calculated as the product of the excess emissions beyond a firm's free allocation and the average simulated allowance price, adjusted to reflect historical costs. For the extreme scenario, the analysis focuses on the most adverse cases, quantified using the conditional Value at Risk (CVaR) metric, which captures the upper five percent of simulated price distributions.

Empirical results show that this enhanced methodology captures a wider range of PD variations across scenarios. Baseline scenarios indicate limited deviations from standard PD estimates, while extreme scenarios reveal significant PD migrations, with firms exposed to higher costs experiencing downgrades and those benefiting from emission-related revenues achieving upgrades. These results underscore the improved sensitivity and accuracy of this approach in evaluating transition risks (Cugliari *et al.*, 2024). Importantly, the use of stochastic scenarios allows the transition risk horizon to align with the one-year credit risk assessment horizon mandated for ICASs.

A survey conducted by the Banca d'Italia in 2024 shows significant discrepancies between sector-based approximations and firm-specific transition and physical risk exposures. Notably, for transition risk, firm-level emissions data lead to more accurate PD adjustments compared to sectoral proxies, particularly for industries with heterogeneous carbon footprints. Similarly, the adjustment to physical risk assessment based on survey data reveals that nearly a quarter of firms had their risk scores modified due to mitigation measures or exposure misperceptions. These findings reinforce the importance of integrating granular firm-level data into ICAS methodologies, complementing stochastic modelling approaches to enhance credit risk evaluation under climate risk scenarios (Colletti *et al*., 2025, mimeo).

References

Angelini P. (2023). SMEs and the climate and environmental transition. Speech at the event *"Finance and ESG disclosure. System solutions for businesses"* organised by Confindustria, Rome, 26 September 2023.

Antilici P., Gariano G., Monterisi F., Picone A., Russo L. (2023). The Eurosystem Collateral Framework and the Measures Introduced in Response to the Pandemic Emergency, in: Scalia, A. (ed.) *Financial Risk Management and Climate Change Risk. Contributions to Finance and Accounting*, Springer, 55-71.

Auria, L., Bingmer, M., Caicedo Graciano, C. M., Charavel, C., Gavilá, S., Iannamorelli, A., ... & Sauer, S. (2021). Overview of central banks' in-house credit assessment systems in the euro area. *Banco de Espana Occasional Paper*, (2131).

Colletti, F., Columba, F., Cugliari, M., Iannamorelli, A., Parlamento, P., & Tozzi, L. (2025). Do firms care about climate change risk? Survey evidence from Italy. *Banca d'Italia, Markets, Infrastructures, Payment Systems* (mimeo).

Cugliari, M., Iannamorelli, A., Vassalli, F. (2025). Modelling transition risk-adjusted probability of default. *Banca d'Italia, Markets, Infrastructures, Payment Systems.*

De Socio, A., Narizzano, S., Orlando, T., Parlapiano, F., Rodano, G., Sette, E., & Viggiano, G. (2020). The Effects of the COVID-19 Shock on Corporates Liquidity Needs, Balance Sheets, and Riskiness. *Banca d'Italia, COVID-19 Notes*.

European Central Bank, The financial risk management of the Eurosystem's monetary policy operations, *European Central Bank*, July 2015.

Faiella, I., Di Virgilio, S., Mistretta, A., & Narizzano, S. (2024). Assessing credit risk sensitivity to climate and energy shocks: Towards common minimum standards in line with the ECB climate agenda. *Journal of Policy Modelling*, *46*(3), 552-568.

Giovannelli F., Iannamorelli A., Levy A., Orlandi M. (2023). The Banca d'Italia's In-House Credit Assessment System for Non-Financial Firms, in: Scalia, A. (ed.) *Financial Risk Management and Climate Change Risk. Contributions to Finance and Accounting*, Springer, 107-137.

Körding, J., & Resch, F. (2022). Common minimum standards for incorporating climate change risks into in-house credit assessment systems in the Eurosystem. *Economic Bulletin Boxes*, *6*.

Mésonnier, J., C. O'Donnell, O. Toutain (2021). The Interest of Being Eligible. *Journal of Money, Credit and Banking, 54*, pp. 425-458.

Narizzano S., M. Orlandi and A. Scalia (2024). The Bank of Italy's statistical model for the credit assessment of non-financial firms. *Banca d'Italia, Markets, Infrastructures, Payment Systems.*

Appendix A

The PD estimates by the statistical model are categorized into risk classes on the internal rating scale and the ratings are then mapped to the corresponding credit quality step (CQS) of the Eurosystem harmonized rating scale (table A1).

Table A1 – Rating scale

(percentage values)

Risk Class of ICAS	Minimum PD	Maximum PD	Eurosystem Credit Quality Step
1	0.000	0.001	CQS 1 & 2
2+	0.001	0.01	
2	0.01	0.03	
2-	0.03	0.05	
3+	0.05	0.07	
3	0.07	0.09	
3-	0.09	0.10	
4+	0.10	0.17	CQS 3
4	0.17	0.30	
4-	0.30	0.40	
5+	0.40	0.80	CQS 4
5	0.80	1	
5-	1	1.50	CQS 5
6+	1.5	2	CQS 6
6	2	3	
6-	3	5	CQS 7
7	5	25	CQS8
8	25	100	
9	100	100	Default

Appendix B

We show 2022 and 2024 median PDs and percentage of firms by sector, size class and geographical area (tables B1, B2, B3).

Table B2

(percentage values)

Sector	PDs 2022	PDs 2024	Firms
Agriculture	1.23	2.07	1.96
Trade	0.80	1.30	21.23
Construction	1.06	1.35	14.24
Energy	0.66	1.15	2.21
Manufacturing	0.36	0.52	21.04
Services	1.22	1.84	39.32

Table B2

(percentage values)

Size class	PDs 2022	PDs 2024	Firms
Micro	1.15	1.76	56.98
Small	0.55	0.86	32.86
Medium	0.43	0.71	8.00
Large	0.47	0.79	2.16

Table B3

(percentage values)

Area	PDs 2022	PDs 2024	Firms
North-West	0.73	1.12	29.48
North-East	0.60	0.91	23.12
Centre	1.03	1.54	22.40
South	1.11	1.66	17.86
Islands	1.18	1.73	7.14

Recently published papers in the 'Markets, Infrastructures, Payment Systems' series

n. 23 Business models and pricing strategies in the market for ATM withdrawals, *by Guerino Ardizzi and Massimiliano Cologgi* (Research Papers)

n. 24 Press news and social media in credit risk assessment: the experience of Banca d'Italia's In-house Credit Assessment System, *by Giulio Gariano and Gianluca Viggiano* (Research Papers)

n. 25 The bonfire of banknotes, *by Michele Manna* (Research Papers)

n. 26 Integrating DLTs with market infrastructures: analysis and proof-of-concept for secure DvP between TIPS and DLT platforms, *by Rosario La Rocca, Riccardo Mancini, Marco Benedetti, Matteo Caruso, Stefano Cossu, Giuseppe Galano, Simone Mancini, Gabriele Marcelli, Piero Martella, Matteo Nardelli and Ciro Oliviero* (Research Papers)

n. 27 Statistical and forecasting use of electronic payment transactions: collaboration between Bank of Italy and Istat, *by* Guerino Ardizzi and Alessandra Righi (Institutional Issues) (in Italian)

n. 28 TIPS: a zero-downtime platform powered *by* automation, by *Gianluca Caricato, Marco Capotosto, Silvio Orsini and Pietro Tiberi* (Research Papers)

n. 29 TARGET2 analytical tools for regulatory compliance, *by Marc Glowka, Alexander Müller, Livia Polo Friz, Sara Testi, Massimo Valentini and Stefano Vespucci* (Institutional Issues)

n. 30 The security of retail payment instruments: evidence from supervisory data, *by Massimiliano Cologgi* (Research Papers)

n. 31 Open Banking in the payment system: infrastructural evolution, innovation and security, supervisory and oversight practices, *by Roberto Pellitteri, Ravenio Parrini, Carlo Cafarotti and Benedetto Andrea De Vendictis* (Institutional Issues) (in Italian)

n. 32 Banks' liquidity transformation rate: determinants and impact on lending, *by Raffaele Lenzi, Stefano Nobili, Filippo Perazzoli and Rosario Romeo* (Research Papers)

n. 33 Investor behavior under market stress: evidence from the Italian sovereign bond market, *by Onofrio Panzarino* (Research Papers)

n. 34 Siamese neural networks for detecting banknote printing defects, *by Katia Boria, Andrea Luciani, Sabina Marchetti and Marco Viticoli* (Research Papers) (in Italian)

n. 35 Quantum safe payment systems, *by Elena Bucciol and Pietro Tiberi*

n. 36 Investigating the determinants of corporate bond credit spreads in the euro area, *by Simone Letta and Pasquale Mirante*

n. 37 Smart Derivative Contracts in DatalogMTL, *by Andrea Colombo, Luigi Bellomarini, Stefano Ceri and Eleonora Laurenza*

n. 38 Making it through the (crypto) winter: facts, figures and policy issues, *by Guerino Ardizzi, Marco Bevilacqua, Emanuela Cerrato and Alberto Di Iorio*

n. 39 The Emissions Trading System of the European Union (EU ETS), *by Mauro Bufano, Fabio Capasso, Johnny Di Giampaolo and Nicola Pellegrini* (in Italian)

n. 40 Banknote migration and the estimation of circulation in euro area countries: the italian case, *by Claudio Doria, Gianluca Maddaloni, Giuseppina Marocchi, Ferdinando Sasso, Luca Serrai and Simonetta Zappa* (in Italian)

n. 41 Assessing credit risk sensitivity to climate and energy shocks, *by Stefano Di Virgilio, Ivan Faiella, Alessandro Mistretta and Simone Narizzano*

n. 42 Report on the payment attitudes of consumers in italy: results from the ecb space 2022 survey, *by Gabriele Coletti, Alberto Di Iorio, Emanuele Pimpini and Giorgia Rocco*

n. 43 A service architecture for an enhanced Cyber Threat Intelligence capability and its value for the cyber resilience of Financial Market Infrastructures, *by Giuseppe Amato, Simone Ciccarone, Pasquale Digregorio and Giuseppe Natalucci*

n. 44 Fine-tuning large language models for financial markets via ontological reasoning, *by Teodoro Baldazzi, Luigi Bellomarini, Stefano Ceri, Andrea Colombo, Andrea Gentili and Emanuel Sallinger*

n. 45 Sustainability at shareholder meetings in France, Germany and Italy, *by Tiziana De Stefano, Giuseppe Buscemi and Marco Fanari* (in Italian)

n. 46 Money market rate stabilization systems over the last 20 years: the role of the minimum reserve requirement, *by Patrizia Ceccacci, Barbara Mazzetta, Stefano Nobili, Filippo Perazzoli and Mattia Persico*

n. 47 Technology providers in the payment sector: market and regulatory developments, *by Emanuela Cerrato, Enrica Detto, Daniele Natalizi, Federico Semorile and Fabio Zuffranieri*

n. 48 The fundamental role of the repo market and central clearing, *by Cristina Di Luigi, Antonio Perrella and Alessio Ruggieri*

n. 49 From Public to Internal Capital Markets: The Effects of Affiliated IPOs on Group Firms, *by Luana Zaccaria, Simone Narizzano, Francesco Savino and Antonio Scalia*

n. 50 Byzantine Fault Tolerant consensus with confidential quorum certificate for a Central Bank DLT, *by Marco Benedetti, Francesco De Sclavis, Marco Favorito, Giuseppe Galano, Sara Giammusso, Antonio Muci and Matteo Nardelli*

n. 51 Environmental data and scores: lost in translation, *by Enrico Bernardini, Marco Fanari, Enrico Foscolo and Francesco Ruggiero*

n. 52 How important are ESG factors for banks' cost of debt? An empirical investigation, *by Stefano Nobili, Mattia Persico and Rosario Romeo*

n. 53 The Bank of Italy's statistical model for the credit assessment of non-financial firms, *by Simone Narizzano, Marco Orlandi, Antonio Scalia*

n. 54 The revision of PSD2 and the interplay with MiCAR in the rules governing payment services: evolution or revolution?, *by Mattia Suardi*

n. 55 Rating the Raters. A Central Bank Perspective, *by Francesco Columba, Federica Orsini and Stefano Tranquillo*

n. 56 A general framework to assess the smooth implementation of monetary policy: an application to the introduction of the digital euro, *by Annalisa De Nicola and Michelina Lo Russo*

n. 57 The German and Italian Government Bond Markets: The Role of Banks versus Non-Banks. A joint study by Banca d'Italia and Bundesbank, *by Puriya Abbassi, Michele Leonardo Bianchi, Daniela Della Gatta, Raffaele Gallo, Hanna Gohlke, Daniel Krause, Arianna Miglietta, Luca Moller, Jens Orben, Onofrio Panzarino, Dario Ruzzi, Willy Scherrieble and Michael Schmidt*

n. 58 Chat Bankman-Fried? An Exploration of LLM Alignment in Finance, *by Claudia Biancotti, Carolina Camassa, Andrea Coletta, Oliver Giudice, Aldo Glielmo*

n. 59 Modelling transition risk-adjusted probability of default, *by Manuel Cugliari, Alessandra Iannamorelli and Federica Vassalli*