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Abstract	We develop a banks specific integrated rating, tailored incorporating the various heterogeneity dimensions characterizing financial institutions (see Mantovani et al. 2013 and 2014 regarding the heterogeneity risk analysis in corporate firms), named bank tailored integrated rating (BTIR). The approach is inherently coherent with the challenging frontier of forecasting tail risk in financial markets (De Nicolò and Lucchetta, J Appl Econ 32(1):159–170, 2017) since it considers the downside risk in the theoretical framework. The innovation consists in using the integrated rating (IR) with the pre-selection of the variables through a statistical procedure that takes into account the characteristics of risk and greater heterogeneity of the banks. A Vector Autoregressive Model (VAR) is only a first simple application proposal.	
Keywords (separated by "-")	Bank tailored integrated rating - Banks' heterogeneity - Financial cycle	

The Bank Tailored Integrated Rating

Daniela Arzu, Marcella Lucchetta, and Guido Massimiliano Mantovani

Abstract We develop a banks specific integrated rating, tailored incorporating the various heterogeneity dimensions characterizing financial institutions (see Mantovani et al. 2013 and 2014 regarding the heterogeneity risk analysis in corporate firms), named bank tailored integrated rating (BTIR). The approach is inherently coherent with the challenging frontier of forecasting tail risk in financial markets (De Nicolò and Lucchetta, J Appl Econ 32(1):159–170, 2017) since it considers the downside risk in the theoretical framework. The innovation consists in using the integrated rating (IR) with the pre-selection of the variables through a statistical procedure that takes into account the characteristics of risk and greater heterogeneity of the banks. A Vector Autoregressive Model (VAR) is only a first simple application proposal.

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1 Motivation and Methodology

The capital regulatory policies imposed on banking institutions, increasingly reveal the need to consider the heterogeneity of regulated entities and, at the same time, to avoid obvious errors above or under assessment of the risks inherent in the various business models of modern banks. The corporate performance literature introduces the Lintner's model [1] as an alternative approach to appraise firms

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and their performance, through the companies' asset-side capability management in the long term. The analysis is useful to understand whether there is an appropriate allocation of financial resources, in line with the goodness of the performance and it is important to assess company pay-out and managerial rents as in Lambrecht and Myers [2]. However, Leibowitz and Henriksson [3] noted that it is important to consider a shortfall approach that looks more on a "confident equivalent", rather that the Lintner's certainty equivalent, which is a minimum threshold that may be overpassed, according to a certain confidence percentage. Determining either the threshold and the confidence is up to the investor, even before choosing the investment. Indeed, in banking analysis the downside risk is particularly important since "tail risk" is considered an important component in financial market analysis as underlined in De Nicolò and Lucchetta [4]. The cited current literature on risk assessment concentrates on corporate firms and the "tail risk" analysis is mainly oriented to macroeconomic risk measures. This paper fills these gaps and contributes to the identification of a synthetic indicator of company performance and long-term creditworthiness, which is also able to take into consideration the investor's risk aversion and the downside risk component: the "bank tailored integrated rating" (BTIR). This need arises from studies on rating modelling in order to make easier the implementation and use of the results within banking organizations. Indeed, it must be ensured that the indicator has three characteristics: (i) scientifically reliable and (ii) comprehensible to customers, finally (iii) consistent with the credit policies adopted. The indicator is inspired by the Integrated Rating methodology [5].

2 Stylized Mathematical Approach

In order to start, we have run a panel regression with components suitable for banks and understand whether the main model might be thought for banks:

$$Y_{it} = \beta_0 + \beta_1 X_{1it} + \cdots + \beta_n X_{nit} + \epsilon_i$$

Where Y_{it} is a banks' performance indicator and βs are banks' health characteristics (Appendix).

We hypothesized to transform the indicator, through a logistic transformation, deriving from the logistic function, which is the better fitting methodology into the whole model. The logistic transformation allows us to have an indicator included in a range between 1 and −1 and a unit standardize and concave curvature. However, it is possible to investigate to detect a multiplicative constant in the exponential component, which changes the degree of curvature of the function, going to change the degree of discrimination of the data set, compared to more extreme values.

$$f(x) = \frac{L}{1 + e^{-k(x-x_0)}}$$

for all the real values of x with codomain $[0, L > 0]$, with inflection point in x_0 and with slope $k > 0$.

The logistics transformation allows us not to overestimate xs that have a better performance, than expectations and do not underestimate xs that are in line with expectations. This effect can be regulated by a multiplicative constant in the exponential component and allows to determine a degree of convexity/concavity that can adapt to the needs. This proxies the differences in risks attitude of the institutions. In conclusion, the bank specific integrate rating project, here detailed, focus our research on the development of a mathematical/econometric method that allows us to identify the best algorithm, to determine a correct degree of convexity and concavity (and therefore, consequently, the correct degree of risk aversion of the investor), which can be dynamic and adaptable, consequently to heterogeneous banks. To take into account the characteristics of risk and greater heterogeneity of the banks, we propose a challenge procedure that employs a Vector Autoregressive Model (VAR) to preselect the relevant banks' variables.

$$VAR\ of\ order\ p : y_t = c + \Phi_1 y_{t-1} + \cdots + \Phi_p y_{t-p} + \epsilon_t$$

Where y_t is a banks' performance indicator, Φ_i: (N*N) $\forall i$ are the other banks' health indicators.

We have chosen the model VAR because it is very simple to implement the selection of important variables using a large number of variable vectors. Furthermore, the VAR procedure makes it possible to recognize at system level the components of systemic risk that would otherwise be ignored without such a process. This further step allows us to design our "bank tailored integrated rating" (BTIR). The approach is inherently coherent with the challenging frontier of forecasting tail risk in financial markets.

3 Summaries and Future Developments

The current development of ever-increasing banking regulations requires the study and the development of increasingly precise rating methods that take into account the increasing heterogeneity of banks and the presence of systemic risk, in addition to ongoing contagion relations between financial institutions. Also, the traditional and simple capital regulatory policies imposed on banking institutions, increasingly reveal the need to consider the heterogeneity of regulated entities and, at

the same time, to avoid obvious errors above or under assessment of the risks inherent in the various business models of modern banks. Our work considers the extension of the integrated rating (IR) procedure, used primarily for non-financial companies, developing the "bank tailored integrated rating" (BTIR). The approach is inherently coherent with the challenging frontier of forecasting tail risk in financial markets [4] since it considers the downside risk in the theoretical framework. The innovation consists in using the integrated rating (IR) with the pre-selection of the variables through a statistical procedure that takes into account the characteristics of risk and greater heterogeneity of the banks. In this first proposal, we use a simple VAR. However, our innovative procedure may include, in the future, more sophisticated pre-selection of variables such as CoVARs. This work requires testing whether a more sophisticated pre-selection model is better than a traditional VAR. In fact, for simplicity, we believe that starting with a simple methodology is the first step of research. Our BTIR makes possible to adapt the rating procedures to all banks, even that showing very different characteristics. In fact, the VAR allows to pre-select and to evaluate markets with high systemic risk, avoiding errors due to general market conditions that may differ from country to country. In conclusion, our BTIR opens the door to a new research line to innovative ideas for the development of increasingly accurate ratings for banks embedding the needs of macro- and micro-prudential policies.

Appendix

Where Bank performance indicator is

$$Decomposed\ ROE = \frac{Pre-Tax\ Profit}{Op.Income} * \frac{Tot.Assets}{Equity} * \frac{Net\ Revenue}{Tot.Assets} * \frac{Op.Income}{Net\ Revenue}$$

(i) is Asset Quality; (ii) Capital Ratios; (iii) Operations Ratios; (iv) Liquidity Ratios; (v) Structure Ratio.

AQ3

		Coefficients	St. errors	
	Intercept	21.1780***	1.5268	t3.1
i	NPL/Gross loans	−0.1550***	0.0353	t3.2
	NPL/Tot. assets	1.1367***	0.0707	t3.3
	NCO/Avg gross loans	0.2954***	0.0872	t3.4
	NCO/Net Inc. bef. Ln Lss Prov.	−0.0028***	0.0008	t3.5
	Impaired loans/Equity	−0.0789***	0.0038	t3.6
ii	Equity/Net loans	−0.0625***	0.0176	t3.7
	Equity/Tot. liabilities	4.5427***	0.3062	t3.8
iii	Profit margin	0.1510***	0.0115	t3.9
	Net Int. Rev./Avg ass.	−0.3912*	0.1613	t3.10
	Non Int. Exp. Avg Ass.	1.2895***	0.2909	t3.11
	Pre-Tax Op. Inc./Avg ass.	3.2931***	0.4963	t3.12
	ROA	6.9032***	0.5271	t3.13
	Cost to income	−0.0355†	0.0196	t3.14
iv	Recurring earning power	−1.3532*	0.6156	t3.15
	Net loans/Tot. assets	−0.0544***	0.0107	t3.16
v	Solvency	−6.8087***	0.4127	t3.17

AQ4

Total sum of squares: 90,259
Residual sum of squares: 6964.1
R-squared: 0.92284
Adj. R-squared: 0.92193
F-statistic: 1055.44 on 16 and 1345 DF, p-value: <2.22e-16
Signif. codes: ***0.001; **0.01; *0.05; †0.1; ††1

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AQ5

AUTHOR QUERIES

AQ1. Please check and confirm if the affiliations are presented correctly.
AQ2. Please provide complete publication details for the reference "Mantovani et al. (2013, 2014)" cited in Abstract.
AQ3. Please check and confirm whether the output of the Table in Appendix is appropriate.
AQ4. Please mark '††' in the body of Table in Appendix.
AQ5. Please update the reference [5], if possible.