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TIME TO GO BEYOND RWA VARIABILITY FOR IRB BANKS: AN EMPIRICAL ANALYSIS

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ABSTRACT

Fifteen years after the introduction of the Basel II Accord, which thoroughly revised the capital framework for banks, internal models are a full part of the supervisory toolkit and the risk management framework of financial institutions. The debate around models has gone through different phases: strong support right before Basel II, seeking greater risk-sensitivity of capital requirements; material concern after the financial crisis, in the light of the high variability of internal models' outcomes; and awareness at the current juncture of their important role in risk management and banking supervision. Despite all initiatives taken by banking regulators and supervisors, a number of questions on banks' risk-weighted assets are still open. The aim of this paper is to provide a different perspective on some of those questions and set the conditions for shifting the attention from simple comparison across banks to an economic interpretation of their risk measures.

KEYWORDS

Bank capital, prudential regulation, risk weights, Basel II

Introduction

More than 15 years ago, the Basel Committee on Banking Supervision introduced into the system of prudential regulation for banks a risk-based framework (Basel II), allowing financial institutions to use internal models to calculate minimum capital requirements for major risk types.[1] Basel II was intended to result in greater risk-sensitivity of capital requirements and was aimed at overcoming the drawbacks of previous rules (Basel I) that had been agreed upon at the international level in 1988 and then adopted in all major jurisdictions. Basel I had the strong merit of introducing, for the first time, common rules and metrics on banks' capital adequacy. Nevertheless, the framework was too simple, i.e. it did not account for the increasing complexity of banks' balance sheets and banks themselves had the (unintended) incentive to save regulatory capital by treating all assets independently by their actual risk profile, thus exploiting arbitrage opportunities. The weaknesses of Basel I emerged already after a few years and regulators gradually came to agree on the need for a thorough revision of the rules.

During the long journey towards Basel II, starting in the mid-1990s, policy-makers and academics conducted a number of analyses focused mainly on the calibration of the absolute level of capital required to banks and on the potential procyclical effects of the rules. Less attention was paid to the implementation aspects of the framework, namely to its complexity. Indeed, it was only a question of time. Since the entry into force of Basel II and the eruption of the financial crisis of 2007–08, an intense debate has developed on the role and meaning of risk-weighted assets (RWA) as the main metric of capital ratios. A number of questions have been raised: are *RWA too variable? Is their variability across banks fully justified? Is banks' discretion in the computation of RWA too high? Are supervisors able to validate RWA?*

A key aspect of the discussion around RWA variability is the distinction between *warranted* (or *intended*) and *unwarranted* (or *unintended*) variability. As mentioned, the ultimate objective of Basel II was to increase the risk-sensitivity of capital requirements, thus accepting by design a higher degree of RWA variability across banks. The issue is how to disentangle the two components of variability.

The idea behind risk-sensitive regulation is that not all bank exposures generate the same risk; therefore, the portion of capital to be set aside to cover possible losses *must* somehow be different. A comparison between the average weightings of different banks therefore makes sense only if a second dimension is considered, i.e. the actual riskiness of the underlying assets. Comparing the average weightings and riskiness of two banks leads to four possible scenarios, shown below.

Figure 1: combinations of weighting and riskiness

		Weightings =	**Weightings** ≠
Risk	=	a	c
	≠	b	d

Cases (a) and (d) correctly reflect the risk-sensitivity principle underlying the prudential regulation: in case (d), one of the two banks has to hold more capital as a result of the greater riskiness of its assets. Conversely, cases (b) and (c) reflect the presence of unwarranted effects. In case (c), one of the two banks holds less capital than the other despite the same risk level, whereas in case (b) the two banks hold the same amount of capital despite

[1] Basel Committee on Banking Supervision (2004), updated in 2005 and then revised in June 2006.

their different risk profiles. Asserting that the differences in terms of average weightings are not justified implies having dismissed a priori the case (d) in favour of case (c). However, it is clear that we cannot discriminate between cases (c) and (d) by looking only at RWA. The objective difficulties of disentangling warranted and unwarranted variability have led over time to a general distrust of RWA as a risk measure.

Banking regulators and supervisors have addressed the issue through a comprehensive set of initiatives aimed at correcting possible pitfalls and regaining the market's trust in RWA. The Basel Committee (with the Basel III package) and, at European level, the European Banking Authority (EBA) have enhanced the framework by introducing a number of corrections to internal model discipline.[2] The European Central Bank (ECB) has undertaken a specific project aimed at assessing the reliability of the internal models of major European banks and introducing measures to increase the homogeneity of approaches across jurisdictions and banks (the targeted review of internal models).

All the above initiatives have contributed to a better understanding of banks' RWA and their variability and have helped to fine-tune policy actions aimed at restoring credibility in RWA calculation. Nevertheless, our impression is that there is still room to address a few open issues and start to focus on new ones. First, *how do we know that RWA variability is too high*? Most analyses have tried to disentangle desired and undesired variability and have reached the conclusion that the unexplained portion of RWA variability is excessive. However, the lack of a quantitative benchmark against which such variability can be assessed leaves some uncertainty about the actual magnitude of the phenomenon. Second, *is RWA variability correctly measured*? The need to find simple metrics has led over time to the use of the ratio of RWA to total assets (RWA density) as the main indicator to look at. However, we show that it is essential to exploit all material information, including both expected and unexpected losses, since RWA density captures only a portion of risk. Third, *is RWA variability the only issue we should investigate*? When dealing with internal models, the key issue is whether they work, i.e. whether the estimated parameters are plausible and meaningful.

This paper aims to address these questions based on empirical evidence from major EU banks: we compare the variability of RWA with the variability of several other indicators computed for the same banks and the impression we derive is that there is nothing special in the variability of RWA. We then show that a portion of RWA variability is explained by the fact that RWA are an incomplete and distorted representation of risk. Finally, we show how all available information could be exploited to gain valuable insights into the adequacy of banks' risk parameters, going beyond RWA variability.

The paper is organised as follows. The next Section reviews the literature; the third Section describes the data; the fourth Section addresses the issue of banks' RWA variability; the fifth Section discusses the shortcomings of RWA density and proposes an alternative metric (total loss ratio); the sixth Section discusses how this metric can be used to build a framework for analysis that helps understating the economics behind risk measures. The last Section concludes.

Literature review

A large stream of literature focuses on the heterogeneity of banks' RWA. An intense discussion has developed in recent years among academics and policy-makers investigating features and behaviours of RWA density. The key issue is that banks may have incentives to reduce the absorption of capital compared with their assets: if two equivalent banks in terms of risk profile report different RWA densities, this may imply that one of the two institutions has underestimated risk. Nevertheless, the major challenge in such analyses is attempting to distinguish between intended variability (due to differences in actual underlying risks) and unintended variability

[2] EBA (2016, 2017).

(arising when regulatory standards are differently implemented or when banks artificially underestimate their risk).

In an extensive report on the internal ratings-based (IRB) modelling practices followed by over 100 European banks, the EBA (2017) surveyed the major aspects of the prudential framework that are interpreted and implemented in different ways. This is an example of work trying to identify the source of RWA variability. Most differences were identified having regard to quite technical aspects, e.g. the treatment of unpaid late fees and capitalised interest or the discounting rate used in loss given default (LGD) estimation. However, not enough evidence was provided on the material impact of these differences. Some other papers are more interested in the quantitative aspects of RWA variability. The sources of information usually exploited are the Pillar 3 reports published by banks, the comprehensive dataset on European banks made available by the EBA as part of its transparency exercise and data collected by supervisors. The resulting works can be classified into three groups.

In the first group, we find papers trying to investigate the relationship between banks' internal measures of risks, typically represented by RWA density, and other risk measures. This is probably the most straightforward approach: if the variability of banks' risk measures is adequately explained by the variability of the underlying risks, then RWA variability is justified. Some of the weaknesses of this stream of research are that market measures of risk often refer to a broad concept of bank risk, i.e. including risks that are not captured by RWA (e.g. liquidity), and reflect a point-in-time perspective (while RWA are based on a long-run horizon).

Hagendorff (2013) shows that RWA are badly calibrated if compared to a market measure of bank portfolio risk. In contrast, Ariss (2017) demonstrates that RWA are affected by the riskiness of an average representative firm but not by market averages of firms' probability of default (PD). Behn et al. (2016) are able to demonstrate that German IRB banks systematically under-predict actual default rates of corporate portfolios. By contrast, Dietsch (2013), who conducted similar research on French banks, reports no similar manipulation of banks' risk measures. Barakova (2014) finds evidence that IRB RWA of major US banks are largely determined by portfolio risks. Based on EBA data for European IRB banks, Dome (2017) finds evidence that RWA are correlated with portfolio risks and with macroeconomic conditions.

In the second group, we find papers trying to explain RWA variability using a number of bank indicators, with the aim of disentangling intended and unintended variability. Most of these papers rely on simple indicators, such as banks' business models or the non-performing loans (NPL) ratio, to overcome the difficulties of finding an appropriate risk measure to be compared with banks' risk measures. In this way, they tend to demonstrate that a significant portion of RWA variability (usually around 50 %) is explained by structural differences across institutions. One of the potential shortcomings of these pieces of research is that it is not explicitly stated what is, or should be, the level of RWA variability to be considered as not excessive. The overall message is, therefore, that the residual variability is somehow too high.

Most of the analyses conducted by regulators and supervisors themselves belong to this stream of literature. The annual report produced by the EBA under the mandate of Article 78 of the Capital Requirements Directive (Directive 2013/36/EU) is a valuable example. For example, the EBA (2018) relies on a specific metric to summarise banks' risk measures, i.e. the global charge (GC), whereby RWA are complemented with expected loss (EL). The analysis shows that a large part of the variability is explained by simple indicators such as the relative size of assets in banks' balance sheets (i.e. the portfolio mix, which is a proxy for the bank's business model), the relative share of defaulted assets and the share of exposures treated under the standardised approach (SA). The most recent report (EBA, 2019) was enriched with additional information collected by banks, i.e. the hypothetical RWA that would be applied using the SA for exposures under the IRB approach. The comparison between the two approaches enabled the conclusion that the IRB approach does not lead per se to greater variability in capital requirements than the variability already embedded in the SA. In other words, the RWA variability induced by the SA is similar to the variability under the IRB approach. The report also exploits data on realised loss figures (the realised default rates), making it possible to verify that the variability under the IRB approach follows the empirical variability of actual risk (observed via default rates), while the variability of RWA in the SA is less closely linked to empirical risk variability.

Other analyses are contained in Arroyo (2010) and Cannata et al. (2012). Avramova (2012) provides evidence on the heterogeneity of RWA density across and within countries, identifying possible driving forces behind such dispersion: banks' business models, the credit quality of asset portfolios, and institutional and accounting differences. Similarly, Resti (2016) confirms that risk weights are significantly affected by a bank's size, business model and asset mix. More recently, Dome (2017) concluded that 56 % of the RWA variability of EU IRB banks is explained by factors reflecting intended sources of variability, such as the proportion of the asset classes, macroeconomic variables and the NPL ratio. This last paper is, in our view, a good example of the abovementioned issue with this strand of literature: despite stating that 'a large share of risk weights variability can be explained by the differences in the underlying risk', he concludes that the residual, unexplained variability is still too high and justifies further action. However, it remains unclear why the residual variability should be considered problematic. In other words, what is the level of variability that should be considered not worrying?

Our paper belongs to this group of papers, even though we try to address the issue of RWA variability from a broader perspective. We compare the variability of the RWA with the variability of other banking indicators in order to try to understand what is special (if anything) in the variability of RWA density. Similarly to Barakova (2014), we suggest switching to a different measure, i.e. the total loss ratio, to summarise the risk measures produced by IRB banks.

The common objective of a third group of analyses is to investigate whether banks adopt the IRB approach for purposes of regulatory arbitrage. Most of these papers search for evidence that banks facing higher costs of capital or having a lower level of capitalisation have underestimated risk. The main challenge for this approach is how to appropriately define the underestimation of risk. Indeed, the simple evidence that the RWA density of a given bank is lower than the average RWA density of a group of banks may be interpreted either as evidence of strategic under-reporting of risk or as evidence of actual lower risk. Merrouche (2014) finds that the reduction of capital absorption observed among IRB banks is greater among weakly capitalised banks. Plosser (2014) provides evidence that low-capital US banks try to improve their regulatory ratios. In addition, he finds that their risk estimates have less explanatory power than those of high-capital banks. Somewhat in contrast, Beltratti (2016) tests over a sample of large international banks the hypothesis that banks with higher costs of equity are more aggressive in reducing risk weights. The results lead to the rejection of the hypothesis.

Data

We use micro-data on European banks to identify a number of bank-specific risk measures. The main database is the EBA's supervisory data, which includes quarterly financial data for a sample of large banks in the European Union. Uniform reporting requirements have been set by the EBA in Commission Implementing Regulation (EU) No 680/2014, the implementing technical standards (ITS) on supervisory reporting. They are mandatory for all European banks.

In terms of content, the ITS cover fully harmonised supervisory reporting requirements for solvency, asset quality, large exposures, real estate losses, financial information, liquidity, leverage ratio and asset encumbrance.

Data are collected at the highest level of consolidation[3] for a sample of large institutions. The sample is made up of almost 200 institutions that meet the criteria laid down in EBA Decision 2015/130: (a) the institution is one of the three largest institutions measured by total assets in the Member State where it is established, including banking groups at the highest level of consolidation and subsidiaries of foreign banking groups; (b) the institution's total value of assets exceeds EUR 30 billion both for institutions that represent the highest

[3] Supervisory information is collected on a solo basis for stand-alone institutions not belonging to a banking group if they meet the criteria.

consolidation level of any given banking group and for non-EEA banking group subsidiaries; (c) the ratio of the institution's 4-year average total assets to the 4-year average GDP of the Member State of its establishment exceeds 20 % both for institutions that represent the highest consolidation level of any given banking group and for non-EEA banking group subsidiaries.

Before being released to users, the data go through an intensive data quality process in which all stakeholders (banks, supervisory authorities and the EBA) are involved. The mandatory quality checks (i.e. validation rules – VRs) are part of the ITS framework and are in place to monitor the consistency and plausibility of the data on submission first to the authorities and thereafter to the EBA. The list of VRs is periodically updated for each new release of the framework and for every quarterly reference date. Once validated, the data enter the EBA data ecosystem, where they serve as the 'backbone' for the production of EU supervisory statistics and risk measures. A comprehensive list of risk indicators is available on the EBA website, which provides guidance on indicators, data sources, the algorithms behind their computation and the methodology followed to support their interpretation and use.

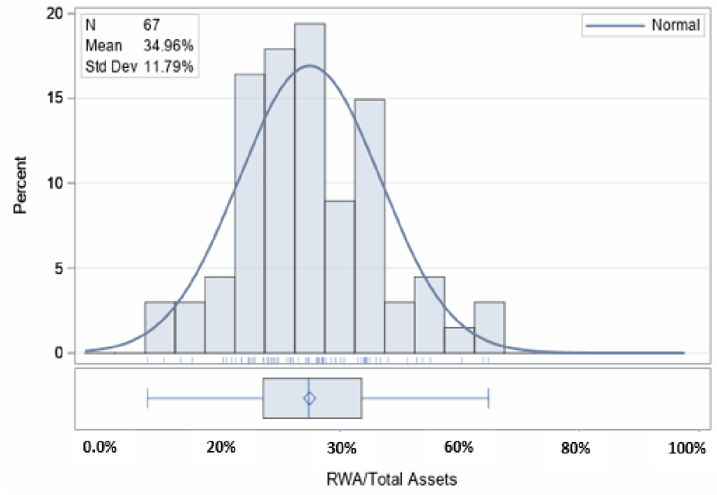
The data used in this paper are used directly by banks to calculate solvency ratios, and therefore are of an overall good quality.

Is RWA variability too high?

In his book *Understanding Uncertainty*, Dennis Lindley (2013) advises the reader that whenever someone makes a statement such as 'A is true', a good starting point for discussion is to ask 'How do you know it?' With this suggestion, Lindley wants to shift attention from the meaning of the statement to the information on which it is based. In our case, if we are asked whether RWA variability across banks is too high, we can easily agree that answering with 'We know it because we have heard someone say it' does not sound very convincing.

In December 2019, the standard deviation of RWA density (i.e. the ratio of total RWA to total assets) for the 67 IRB banks reporting to the EBA was 11.8 %. This is a fact. The range of variation between the 95th and the 5th percentiles was 43 percentage points, i.e. 90 % of the banks had an RWA/TA value between 54.2 % and 11.3 % (Figure 2). Our first impression is that the variability is too high. This is a judgement. How can we state that these values represent excessive variability? What would be a not excessive, i.e. acceptable, value? This is the question that this section deals with.

Figure 2: RWA density (RWA/total assets), IRB banks, December 2019



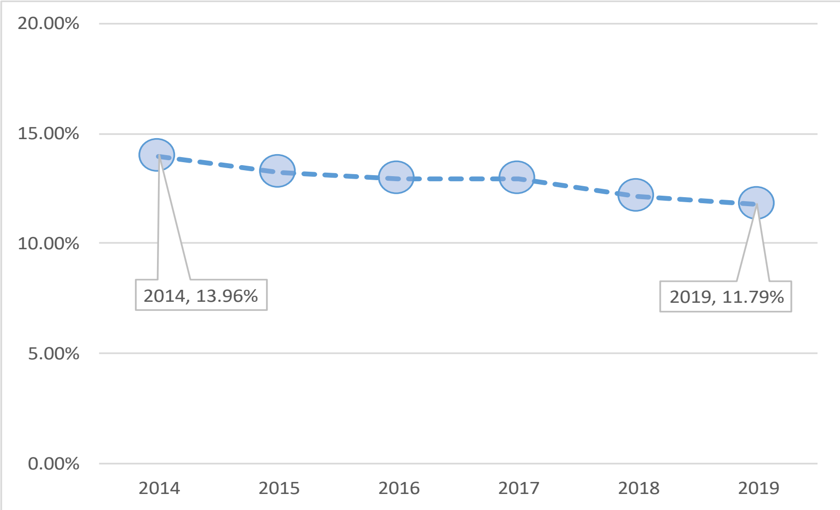
The key point is that, in order to make a credible assessment about a quantity, we need to compare it with a benchmark. Indeed, if we search for a definition of the term 'measure', we find the following:[4] 'To ascertain the extent, dimensions, quantity, capacity, etc., of, especially by comparison with a standard'.

The impression that the IRB approach produces too much dispersion in terms of risk measures is certainly due in part to qualitative reasoning and not only to a mechanistic reliance on specific indicators such as the standard deviation and the range of variation in RWA density at bank level. The supervisory experience gathered over time has demonstrated that banks tend to adopt quite differentiated approaches. However, having a quantitative measure of the phenomenon (e.g. the variability of RWA density) is key to allow all stakeholders to gauge its materiality and, as far as regulators and supervisors are concerned, to decide on policy actions. This is why the definition of a benchmark can be extremely useful. To this end, we follow a two-step approach. First, identifying a phenomenon whose variability can be considered normal; second, comparing a measure of its variability, such as the standard deviation, with a measure of the variability of banks' RWA (the standard deviation of RWA density).

The definition of a benchmark for RWA variability is not straightforward. Consider, for example, the time series of the standard deviation of RWA density for IRB banks. Figure 3 shows a downwards trend between 2014 and 2019, from 14 % to 11.8 %. The reduction might be explained by the efforts made by regulators and supervisors but the question remains unanswered: is the variability still too high? Having a reference value, reasonably different from zero, is helpful in understanding whether we can expect a further reduction or whether more supervisory action is needed.

[4] https://www.dictionary.com/browse/measure. See also Lindley (2013): 'The key idea is that all measurements ultimately consist of comparison with a standard with the result that there are no absolutes in the world of measurement.'

Figure 3: Standard deviation in RWA density (RWA/total assets), IRB banks, December 2014 to December 2019



Preliminarily, it is necessary to decide on an alternative definition of RWA density. In spite of its simplicity, the usual indicator has some limitations. It brings together all Pillar 1 risks (credit, market, operational), but, while for credit risk there is a clear component of total assets that can be easily identified (i.e. credit exposures), for the other Pillar 1 risk types (market and operational), the relevant component is less clear or RWA cannot be associated with any particular type of asset. Moreover, RWA are associated also with off-balance-sheet exposures, which are not included in total assets. Therefore, the numerator is clearly inconsistent with the denominator. The alternative definition of RWA density we have identified is the following: RWA^C/EAD, where RWA^C is the amount of RWA stemming from credit risk only and *EAD* is exposure at default.[5] Table 1 enables a comparison of the two definitions of RWA density. For the 67 IRB banks in our sample, the standard deviation for the new definition (credit RWA density) is in fact slightly higher than that for the usual RWA over total assets ratio (13.6 % versus 11.8 %).

A natural candidate for a benchmark for IRB RWA variability would be the variability of RWA under the SA, where risk weights are defined in the regulation and banks have only to classify their assets according to predefined categories. It can be safely assumed that SA variability is not influenced by banks' estimates and, therefore, does not offer significant room for gaming the rules.[6] However, since IRB banks do not report, under the ITS 680/2014 framework, also the RWA that would be obtained under the SA, we compare the variability of the RWA density of the IRB banks with the variability of the same indicator computed for the 32 SA banks reporting to the EBA.[7]

[5] EAD is equal to the post-credit risk mitigation (CRM) substitution effect drawn exposure plus the undrawn exposure weighted by the credit conversion factors.

[6] In practice, what matters under the SA are only the rules for the classification of loans among asset classes. Such rules can be rather complex, such as for CRM, and banks can interpret or implement them in different ways. Therefore, it cannot be ruled out that some unwarranted RWA variability may occur also under the SA approach. However, most of the attention from regulators and supervisors has been concentrated so far on reducing variability under the IRB approach. We therefore infer, for the purpose of our analysis, that variability under the SA is not considered a problem.

[7] While RWA calculated using the IRB and the SA are comparable, in the latter approach EAD is computed as net from credit risk adjustments while in the former it includes such adjustments. For this reason, we added back the provisions to the SA EAD.

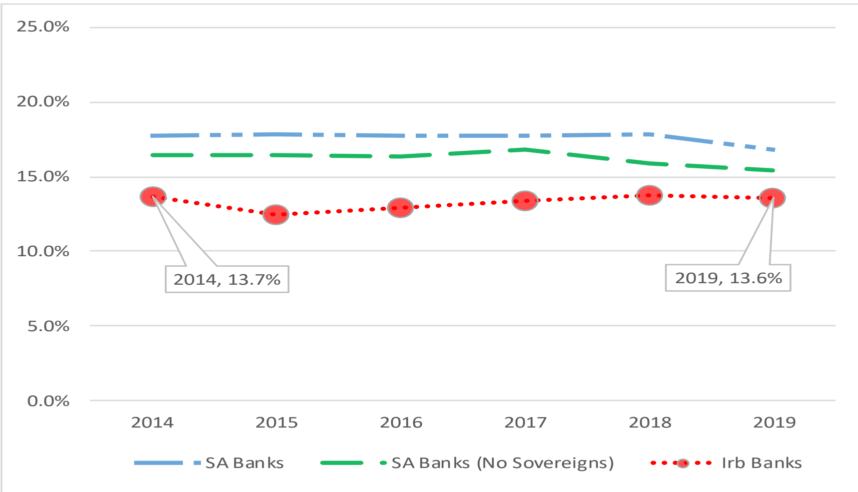
Table 1: RWA density and credit RWA density for IRB and SA banks, December 2019

	IRB BANKS		SA BANKS		
	excluding PPU and RO		all portfolios		no Sovereigns
	RWA/TA	RWA^{C}_{IRB}/EAD_{IRB}	RWA/TA	RWA^{C}_{SA}/EAD_{SA}	RWA^{C}_{SA}/EAD_{SA}
avg	35.0%	32.0%	51.2%	44.3%	59.4%
std	**11.8%**	**13.6%**	**19.6%**	**16.8%**	**15.4%**
p5	15.4%	11.0%	8.2%	7.9%	28.4%
p95	55.1%	57.6%	75.4%	70.9%	80.4%
range	39.7%	46.6%	67.2%	63.0%	51.9%
N	67		32		

The result is rather surprising. If we accept that the variability under the SA is not excessive, then we should conclude that a standard deviation of about 17 % (or 15 % excluding sovereigns[8]) in RWA is not an issue either. Consequently, the standard deviation under the IRB approach (13.6 %) should not be deemed excessive either. We have seen in Section 2 that, in the context of the most recent EBA benchmarking report (i.e. EBA 2019), IRB banks reported also the risk weights that would be applied under the SA. This enabled to make that comparison that we could not do given the reliance on ITS 680/2014 i.e. to compare the variability of the average risk weights on the same exposures. The results confirm our major finding, i.e. RWA variability generated by the IRB approach is not higher than the variability that would be observed under the SA.

Even more surprising is what arises from an analysis of the variability of credit RWA density over time. Figure 4 shows not only that the variability of RWA resulting from the IRB approach has been steadily lower than the variability generated by the SA but also that the variability stemming from the IRB approach has remained substantially unchanged in recent years.

Figure 4: Standard deviation in RWA density (credit RWA/EAD), IRB and SA banks, December 2014 to December 2019



[8] We know that for the sovereigns portfolio the SA is more convenient than the IRB approach, so that it is common to find a large part of these portfolios under the SA also for IRB banks. For this reason, we deem the comparison more appropriate if we exclude all the sovereigns portfolios classified under the SA.

A problem of comparing the variability of credit RWA density in IRB and SA banks is that it involves non-comparable institutions, even though they are all large banks. Therefore, we propose an alternative comparison. For the 67 IRB banks, we compute the standard deviation (and range of variation) of several indicators whose variability can be deemed normal.[9] The message from Figures 5a and 5b seems to be that variability is a common feature when different banks from different countries are taken in consideration. Moreover, the variability of credit RWA density does not appear very different from that one stemming from other phenomena. The lowest variability (standard deviation equal to 1.5 %) is associated with the leverage ratio, and, therefore, we treat this standard deviation as a benchmark for comparing the variability of the other indicators. The variability of RWA density is 8 times higher than that of the leverage ratio. This is the first keystone of our line of thought: we know that RWA are a risk-sensitive measure; therefore, it is not surprising that their variability is higher than that of the leverage ratio (which is, by design, a non-risk-sensitive measure). The point is, therefore, whether 8 times higher is an acceptable level.

The analysis shows that the variability is even higher for other indicators such as the NPL coverage ratio and the level of asset encumbrance, and this seems to confirm the impression obtained from comparing the variability of IRB and SA RWA, i.e. the variability of IRB RWA does not seem to be abnormal.

We know from several papers that a substantial part of the IRB RWA variability can be easily explained by simple concepts such as banks' business models. For example, it is easy to find a relationship between the average risk weights at bank level and the relative share of residential mortgage exposures, which are typically associated with a lower risk profile. Banks that specialise in the residential mortgages business tend to have RWA densities that are significantly lower than those of other banks. This is clearly a huge source of variability, and it is clearly classifiable as intended. Roughly speaking, this means that once we control for these factors, the residual RWA variability is about 4 times the variability of the leverage ratio.

[9] The selected indicators are the following: (1) bank size, defined as the bank's total assets divided by the sum of the total assets over the whole sample; (2) the NPL ratio, (3) return on equity (ROE); (4) the ratio between derivatives and total assets; (5) the LCR buffer, defined as the amount of highly liquid assets exceeding the minimum requirements divided by total assets; (6) the leverage ratio; (7) the share of off-balance sheet assets, computed using the definition of total exposure used in the computation of the leverage ratio; (8) the ratio of secured funding (covered bonds and asset-backed securities over total liabilities); (9) the share of RWA stemming from market risk and operational risk over the total amount of RWA; (10) net fee and commission income over total net operating income; (11) total encumbered assets and collateral over total assets; (12) the relative share of EAD treated under the SA (i.e. the share of EAD in the permanent partial use (PPU) portfolios); (13) the share of EAD classified in the residential mortgages portfolio, (14) the ratio of provisions to NPLs; (15) the ratio of staff expenses to administrative expenses; (16) the cost-to-income ratio; (17) the net interest income ratio, (18) the ratio of loans to total assets.

Figure 5a: Standard deviation in IRB RWA density and other indicators, IRB banks, December 2019

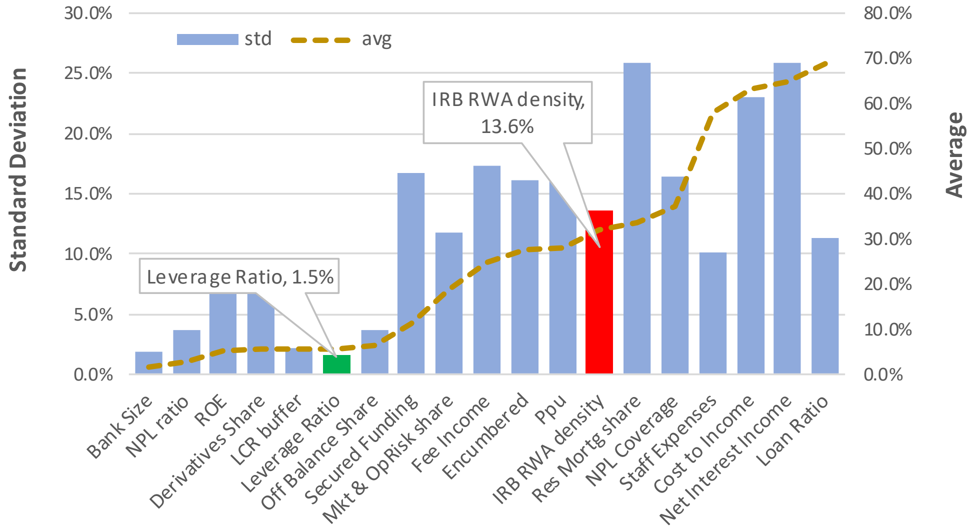
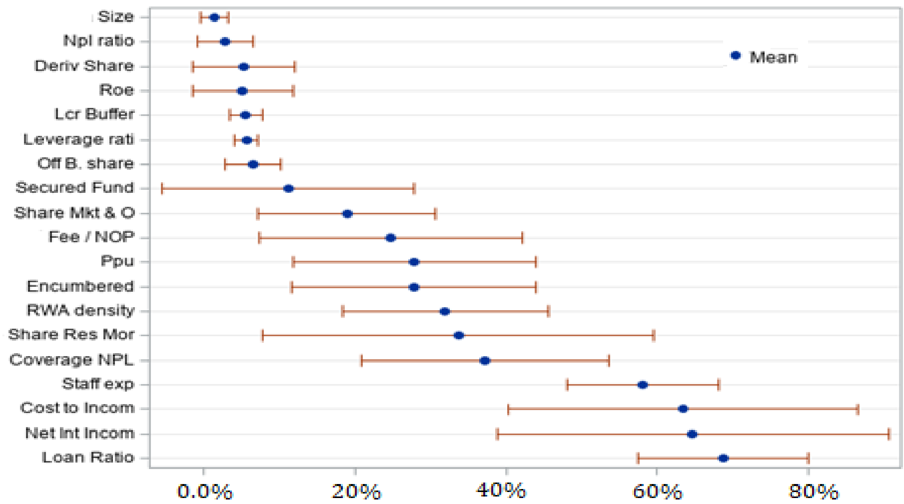


Figure 5b: Box plot of variability of IRB RWA density and other indicators, IRB banks, December 2019



In conclusion, when we compare the variability of banks' RWA with the variability of other banking indicators, it is hard to understand what is exceptional about it. We can thus infer that the variability of banks' RWA does not seem to be excessive in relative terms.

Expected, unexpected and total loss: understanding RWA

Banks' RWA represent the unexpected loss (UL) associated with a portfolio, i.e. the amount of loss exceeding the EL within a given confidence level. The idea behind RWA is that of value at risk (VaR). Although the first predecessors of VaR can be traced back to the beginning of the 20th century, the credit for the current use of VaR is commonly given to US bank J.P. Morgan.

As far as credit risk is concerned, Basel regulators explicitly introduced the split of VaR into two components (EL and UL) in order to recognise the different roles of credit adjustments (provisions and partial write-off) and capital. The former covers EL while the latter covers UL.[10] Although there were good reasons (from prudential and accounting points of view) for introducing this split, this has led to attention being concentrated on UL, expressed in terms of RWA and proxied by RWA density. Nevertheless, it should be understood that the real risk measure is still the sum of both components, i.e. the total loss, which can be computed as 8 % of RWA (i.e. the minimum capital) plus EL. Dividing this quantity by the EAD, we derive a total loss ratio (TL ratio), which represents the estimated VaR at 99.9 % for the credit portfolio.

It is worth mentioning that the very same concept was adopted by the Basel Committee in the revised framework for the prudential treatment of securitisations, with the introduction of a specific parameter (KIRB) for the computation of the capital charge of each tranche.[11] The economic interpretation of KIRB is straightforward, i.e. it is compared with the attachment (A) and detachment (D) points of each tranche of the securitisation.[12] If D is lower than KIRB, the tranche is associated with the maximum risk weight (1 250 %), i.e. the corresponding capital requirement is equal to the exposure. It is easy to see that the definition of KIRB coincides exactly with the above definition of total loss, and its regulatory use in the context of securitisations reinforces the impression of an indicator with a clear economic interpretation. Moreover, in the context of the analyses conducted under the mandate of Article 78 of the Capital Requirements Directive, the EBA relies on GC rather than RWA and the TL ratio is simply equal to 8 % * GC.

A simple example can show how the two metrics (RWA density and TL ratio) can be interpreted, with the latter being clearly more straightforward. Considering only performing exposures, the average RWA density for the European IRB banks at December 2019 was 24.6 % (Table 2), but, in order to get a monetary value, we need to multiply it by 8 %, i.e. 8 % * 24.6 % * EUR 100 = EUR 1.97. This is the amount of loss exceeding the EL that we can expect from a portfolio of EUR 100. Still, the amount remains unclear if we do not know the value of EL. Conversely, the TL ratio can be easily interpreted as the maximum loss that can be expected with a given

[10] It is worth mentioning that, at the time of the Basel II discussion, the accounting framework envisaged for the provisions the 'incurred loss' approach. Under this approach, little room for things such as statistical models could be found in the accounting framework and probably this contributed to the separation between EL and UL. This makes it possible to see the introduction of models as having an impact only on the capital side and not influencing provisions policies. However, the IRB approach produce both EL and UL measures and the EL plays a key role. In a sense, the separation between EL and UL was functional, to avoid the prudential regulation having an impact on accounting aspects.

[11] For IRB banks, the parameter is calculated as follows (Basel Committee on Banking Supervision, 2016, paragraph 49): 'KIRB is the ratio of (a) the IRB capital requirement including the expected loss portion ... to (b) the exposure amount of the pool ... . KIRB must also include the unexpected loss and the expected loss associated with defaulted exposures in the underlying pool.'

[12] Unlike vertical tranches, tranches that absorb losses sequentially offer a spectrum of risk characteristics and, thus, appeal to a broader investor base. Such tranches are defined by an attachment and a detachment point. The attachment point indicates the minimum amount of pool-level losses at which a given tranche begins to suffer losses. In turn, the detachment point corresponds to the amount of pool losses that completely wipe out the tranche. See also Antoniades-Tarashev (2014), *BIS Quarterly Review*.

confidence level. So the value of 2.2 % means that for a portfolio of EUR 100 we can expect to lose at the maximum (with a 99.9 % confidence level) EUR 2.2.

Table 2: RWA density and TL ratio for IRB banks, December 2019

	RWA_{IRB}^{C} / EAD_{IRB}	TL / EAD_{IRB}
Non-performing	46.2 %	47.8 %
Performing	24.6 %	2.2 %
All	29.2 %	3.4 %
$TL = 8\% RWA_{IRB}^{C} + ELA$		

As regards the difference between the two metrics, we observe that this is quite low for non-performing exposures and much larger for performing exposures. This is rather intuitive: in the former case, a portion of risk has become a fact: the credit event (the default) has occurred; the corresponding PD is 100 % and the residual risk is represented only by recovery from the default. In this situation, EL matters much more than UL. This suggests that, at least for non-performing exposures, paying attention only to RWAs (i.e. UL) entails disregarding the largest portion of the estimated risk.

In order to gain a proper understanding of the variability of the risk measures produced by banks, another dimension of the problem has to be addressed. It should be clear that the maximum amount of loss should never exceed the level of the exposure itself. If you lend EUR 100, the worst thing that can happen is that you lose the entire amount. In other words, the TL ratio should always be ≤ 100 %. This seems quite naive, but it is not, especially when dealing with banks' RWA for non-performing exposures. Consider, for example, the NPL portfolios of two banks. Bank A has EL equal to 95 % and the risk weight is 62.5 %. Bank B has EL equal to 90 % and the risk weight is 125 %. The range of the variation of the two risk weights appears wide: from 125 % to 62.5 %. However, the two banks are estimating the very same TL:

Total loss (= VaR) bank A: (95 % + 62.5 % * 8 %) * EUR 100 = EUR 100

Total loss (= VaR) bank B: (90 % + 125 % * 8 %) * EUR 100 = EUR 100

The risk weight of bank A is influenced by the fact that the EL is already quite high.

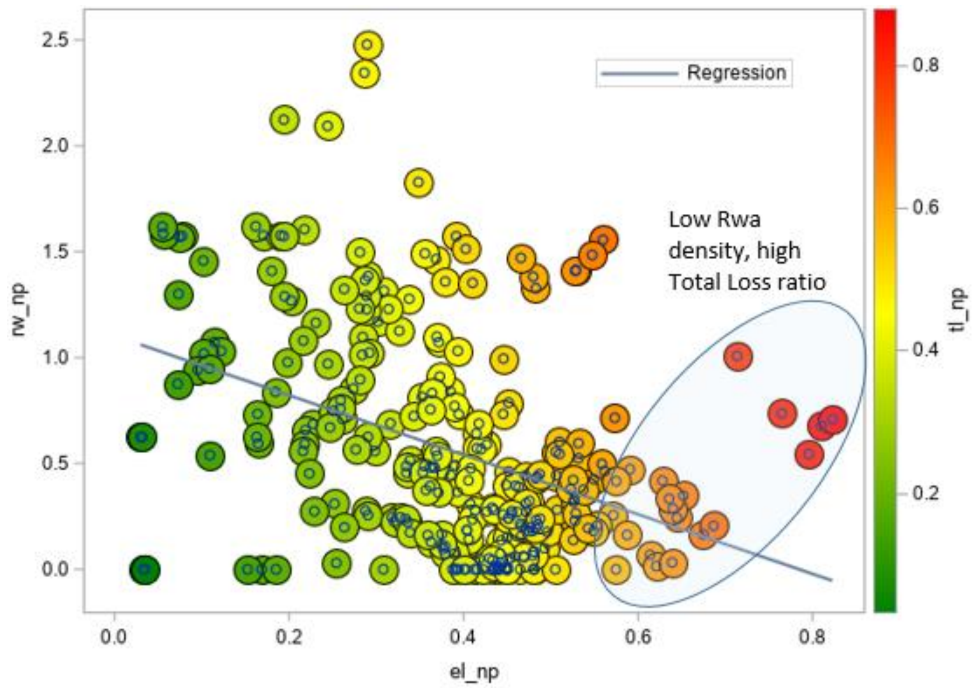
It is also worth noting that relying on measures such as the TL ratio or GC is essential when dealing with banks using the foundation IRB approach (i.e. not using own LGD estimates), as for defaulted assets the risk weight is set at 0%[13], which is further illustration of the problems one can encounter when looking only at RWA variability. The metric adopted in the EBA benchmarking report, GC, takes into account both an EL and a UL component.

Figure 6 confirms that for non-performing exposures there is a clear link between risk weights and EL. The regression line between the two has a negative shape, i.e. the higher is the EL ratio, the lower are risk weights. In addition, banks associated with low average risk weights tend to have a high TL ratio.

It should be clear that, for non-performing exposures, looking only at average risk weights, it is easy to arrive at the wrong conclusion that banks with low RWA density are less prudent; in fact, it is possible that the low RWA density is justified by a high level of EL. More generally, this leads to an artificial increase in the perceived variability of risk measures. For performing exposures, the problem is less material because EL matters much less than UL. However, when RWA density is calculated at portfolio level, performing and non-performing exposures are usually mixed together.

[13] Article 153(1)(ii) of the CRR.

Figure 6: Non-performing loans: RWA density and average EL and TL ratios, December 2014–December 2019



After discussing the advantages of the TL ratio over RWA density, we come back to the issue of variability. Table 3 shows the distribution of RWA density and TL ratio for performing, non-performing and total exposures. The variability of the TL ratio is far lower than that of RWA density. Comparing the figures in Table 3 with those in Figure 5a, we can see that the variability of the TL ratio is quite low compared with that of the other indicators. The standard deviation in the TL ratio (3.1 %) is only about twice that in the leverage ratio (1.5 %, see Figure 5a).

Table 3: RWA density and TL ratio for IRB banks, December 2019

	NON-PERFORMING		PERFORMING		ALL	
	$\frac{RWA^C_{IRB}}{EAD_{IRB}}$	$\frac{TL}{EAD_{IRB}}$	$\frac{RWA^C_{IRB}}{EAD_{IRB}}$	$\frac{TL}{EAD_{IRB}}$	$\frac{RWA^C_{IRB}}{EAD_{IRB}}$	$\frac{TL}{EAD_{IRB}}$
avg	46.2%	47.8%	24.6%	2.2%	29.2%	3.4%
std	**46.7%**	**14.7%**	**11.2%**	**1.2%**	**13.6%**	**3.1%**
p5	0.0%	18.4%	9.2%	0.8%	11.0%	1.1%
p95	158.5%	66.2%	46.4%	4.1%	57.6%	9.2%
range	158.5%	47.8%	37.2%	3.3%	46.6%	8.1%

Table 4 compares, for the same 67 IRB banks, the variability of credit RWA density with that of the leverage ratio and the TL ratio over the period 2016–2019. The variability of the TL ratio is only slightly more than twice that of the leverage ratio. It is important to highlight that RWA density and the TL ratio are produced by the same IRB models. This means that a simple rescaling of RWA completely changes the perspective as regards variability. Although the TL ratio is a broader measure of risk than RWA density, its variability is far lower. There are two main reasons for this. The first is the scaling. RWA are equal to UL by a factor of 12.5, while the minimum required capital is equal to 8 % of RWA, that is 8 % * 12.5 * UL = UL. The second is less intuitive: as we have shown, there may be compensation effects between EL and UL, in particular for non-performing loans. With the TL ratio, these compensation effects are accounted for. It is interesting to observe that the variability of the TL ratio in relation to the performing exposures follows a downwards trend, and this could be interpreted as reflecting the effect of the efforts undertaken by regulators and supervisors.

Table 4: Standard deviation of leverage and TL ratios, December 2016–December 2019

Year	Leverage ratio	RWA density	TL ratio		
			ALL	Performing	Non-performing
2014		13.7%	**4.1%**	1.8%	10.5%
2015		12.4%	**4.3%**	1.7%	11.7%
2016	1.5%	12.9%	**4.5%**	1.4%	12.5%
2017	1.6%	13.4%	**4.5%**	1.3%	13.4%
2018	1.5%	13.8%	**3.6%**	1.2%	13.8%
2019	1.5%	13.6%	**3.1%**	1.2%	14.7%

In conclusion, the TL ratio, which includes both the EL and the UL components of credit risk, seems to be more intuitive and comprehensive than RWA. Moreover, the variability across banks of this indicator is far lower than that of RWA. In a sense, the reduction in the variability observed for the TL ratio is a trivial result. We know, for example, that the variance of a random variable multiplied by a scalar increases with the square of the scalar. In the same way, multiplying the risk measure total loss by 12.5 increases variability.

There is life beyond RWA variability

The final part of our investigation moves from RWA variability to another area of analysis, i.e. whether banks' models produce proper risk measures. Given that we cannot perform a proper back-testing exercise, because of a lack of information, we offer an alternative route, i.e. comparing the risk measures produced by a bank with the potential risk, without the need to compare them with the measures produced by other banks. The aim of this section is to argue that the IRB approach is not a black box the outcomes of which are difficult to understand, with the only possibility being to compare results across banks. We attempt to compare those outcomes with concrete phenomena, in order to extract in a meaningful and pragmatic way valuable information for both analysts and supervisors.

Let us consider one of the 67 banks in our sample (bank A) and one subportfolio (residential mortgages). At the end of December 2019, the RWA density for performing exposures was 15.9 %. That means that we can expect that the loss generated by a portfolio of, say, EUR 1 000 will be at most (with a 99.9 % level of confidence) higher than the EL by an amount equal to EUR 1 000 * 15.9 % * 8 % = EUR 12.72. What can we say about it? Probably the easiest thing is to compare this figure with similar figures from other banks. However, in this way we are not verifying whether the risk measure is adequate or not for bank A. Therefore, we have to take another route.

The average PD estimated by the bank at portfolio level was 1.25 % and the average LGD was 16 %. EL is equal to PD * LGD = 0.2 %. The risk weight (RW) is equal to TL minus EL:

$$RW = (TL - EL) * k = [TL - (PD * LGD)] * k$$

where $k = 12.5 * 1.06$.

TL is obtained by multiplying the 'stressed' PD and LGD, which represent the level of the parameters that would be observed in downturn conditions.

$$RW = [(PD^{stressed} * LGD^{stressed}) - (PD * LGD)] * k$$

The regulation requires that EL be computed using the same LGD used for TL, hence RW is obtained as follows, i.e. it is proportional to the difference between the stressed PD and the average PD:

$$RW = [(PD^{stressed} * LGD^{stressed}) - (PD * LGD^{stressed})] * k =$$

$$= [LGD^{stressed}(PD^{stressed} - PD)] * k$$

The stressed PD is calculated using the supervisory formula as a function of the average PD and a parameter, R, named asset correlation.

$$PD^{stressed} = \Phi\left(\frac{\Phi^{-1}(PD)}{\sqrt{1-R}} + \sqrt{\frac{R}{1-R}}\,\Phi^{-1}(0.999)\right)$$

By applying the formula above with *R* = 15 % to all PDs estimated by the bank for each rating grade and averaging the result, we obtain an average stressed PD equal to 8.76 %:

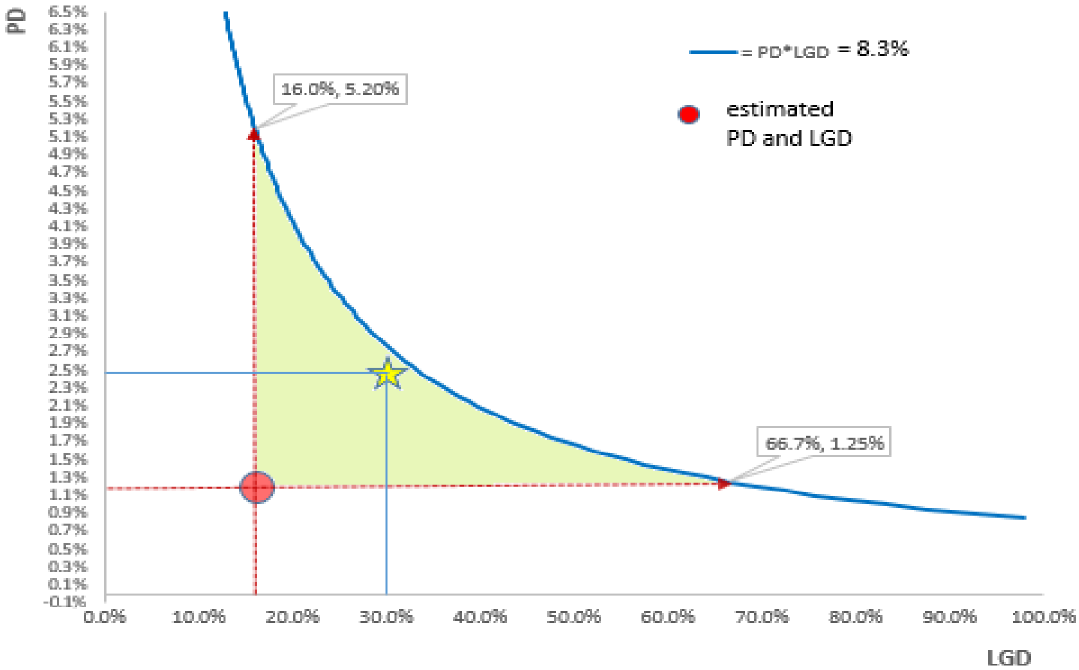
$$RW = [16\% * (8.76\% - 1.25\%)] * 12.5 * 1.06 = 15.9\ \%$$

The risk fund represented by the sum of provisions and capital requirements would be able to absorb an increase in the annual default rate up to 8.76 % with an associated 16 % LGD. Now suppose that bank A has a Common Equity Tier 1 (CET1) ratio equal to 11 %. This means that the bank has an extra capital cushion of 4 percentage points of RWA on top of the minimum requirements (including the capital conservation buffer).[14] We can compute the monetary value of this capital cushion as EUR 1 000 * 15.9 % * 4 % = EUR 6.36. EL was 0.2 %, so the EL amount was 0.2 % * EUR 1 000 = EUR 2. We can assume that the EL is covered by provisions and so, summing the capital cushion and the EL amount, we have EUR 6.36 + EUR2 = EUR 8.36. This amount can be seen as a risk fund, i.e. the loss that the bank could suffer without eroding the minimum capital requirements.

Figure 7 shows the combinations of PD and LGD that produce a loss equal to EUR 8.36/EUR 1 000. The red dot represents the estimated average PD (1.25 %) and average LGD (16 %). It can be seen, for example, that, given the LGD, it would take a default rate equal to 5.2 % (4 times higher than the estimated PD) to generate a loss sufficient to wipe out the risk fund constituted by the capital cushion plus the provisions. In the same way, given a PD equal to 1.25 %, it would take a level of LGD equal to 67 % to cause the same result. The green area represents the combinations of default rates and loss rates that, although higher than the estimated parameters, would lead to a loss lower than the risk fund. Suppose now that we can reasonably expect a default rate not higher than, for example, 2.5 % and a loss rate of 30 %. This combination is represented by the yellow star; the realised loss (0.75 %) would not be enough to fully absorb the risk fund.

[14] Alternatively, we could have transformed the RWA in capital with the usual 8 % factor or a 7 % factor, since we are talking about CET1. We prefer to refer to the difference between the buffer and the minimum requirement for two reasons: the first is to bring into the analysis the capital buffer. Nowadays, almost all banks have capital ratios higher than the minimum requirements and often well above. It is possible to imagine that this fact is partially due to market pressure, so that these capital buffers can be seen as structural. The second reason is that we do not want to bring into the discussion the issue of bank failure. In other words, it is not so easy to say that a bank can consume even a part of its minimum capital. We therefore prefer to consider only the additional capital as the amount that can be used to absorb losses.

Figure 7: Combinations of PD and LGD



This example shows that, although it is not easy to find appropriate data to perform a proper back-testing exercise of banks' risk measures, there is room to exploit available data to assess whether the parameters estimated by banks are adequate or not, and we believe this could be more informative than a comparison of institutions' RWA densities.

Conclusions

Banks' internal models and their use in financial regulation have been among the most controversial topics in the post-crisis discussion. After years of debate on their role in the prudential framework and a number of proposals to mitigate shortcomings and possible undesired effects, the framework is now fixed and models are likely to remain an important component of risk management and banking supervision. Among the non-quantitative advantages of the IRB models, it is worth mentioning that they allow banks to better understand the risks of their portfolios. This additional knowledge arising from the use of IRB models actually helps banks to reduce (or at least better manage) the overall risk supported by the banking system. The Basel II standards also gave a significant boost to the culture of data collection. The amount of data that are available nowadays, for example through the Pillar 3 templates and the EBA transparency exercise, would have been unimaginable until a few years ago.

This is all the more true having regard to the new accounting standards (International Financial Reporting Standard 9, see Bcbs (2015)). Therefore, together with internal models, we are bound to live with the variability of their outcome.

Our impression is that it is too simplistic and unrealistic to imagine a situation where all banks produce the same risk measures or where all differences in the estimates are easily explained. Indeed, in recent years we have learned that behind the variability of these measures there are complex phenomena, such as the levels of risk aversion of banks and differing supervisory approaches. Therefore, we may reach a point where we have to accept that it is not possible to go below a certain level of variability. So what should this point be? Should be worry instead about something else and learn to better exploit available information? The conclusions of our paper – based on a sample of European banks observed over a period of 6 years – offer, in our view, some convincing answers to the above questions.

- A comparison with the variability of a number of other banking characteristics (e.g. profitability and its components, business model, financing policies) provides no convincing evidence that RWA variability is special in any sense.
- A significant portion of RWA variability can be explained by structural factors, i.e. the undesired portion of variability is rather low.
- A better understanding of the risk measures produced by banks is needed. RWA provide only a partial representation of these measures: reliance on a more intuitive metric, such as the TL ratio, might help in better interpreting the underlying economic meaning of these measures.
- Finally, even though a proper back-testing exercise cannot be easily performed with publicly available data, there is room to exploit available data to assess whether the parameters estimated by banks are adequate or not, without relying on comparisons with other institutions.

Our conclusions are relevant from a policy perspective. Interpreting RWA variability in the correct way and focusing on a comprehensive metric for banks' risk levels might help supervisors to better use the outcomes of their RWA analyses to inform their actions and enable market analysts to focus on what really matters.

References

Antoniades A. and Tarashev N. A., (2014) *Securitisations: Tranching Concentrates Uncertainty*. BIS Quarterly Review December 2014

Ariss R., (2017), *Heterogeneity of Bank Risk Weights in the EU: Evidence by Asset Class and Country of Counterparty Exposure*. IMF working papers

Arroyo J., Colomer I., Garcia-Baena R. and Gonzalez-Mosquera L. (2012), *Comparing risk-weighted assets: the importance of supervisory validation processes*, Estabilidad Financiera, n. 22, Banco de Espana.

Avramova S. and Le Leslé V., *Why Do RWAs Differ Across Countries and What Can Be Done About It*?, IMF working papers

Basel Committee on Banking Supervision (2004), *International convergence of capital measurement and capital standards (Basel II) a revised framework*, Basel Committee on Banking Supervision, Basel.

Basel Committee on Banking Supervision (2015), Guidance on credit risk and accounting for expected credit losses, Basel Committee on Banking Supervision, Basel.

Basel Committee on Banking Supervision (2016), *Revisions to the securitisation framework*, Basel Committee on Banking Supervision, Basel.

Basel Committee on Banking Supervision (2016), *Reducing variation in credit risk-weighted assets – constraints on the use of internal models*, Basel Committee on Banking Supervision, Basel.

Barakova, I. and Palvia A. (2014), ‘Do banks’ internal Basel risk estimates reflect risk?’, *Journal of Financial Stability*, Vol. 13, pp. 167–179.

Begley, T. A., Purnanandam, A. and Zheng, K. (2017), ‘The strategic under-reporting of bank risk,’ *Review of Financial Studies*, Vol. 30, No 10, pp. 3376–3415.

Behn, M., Haselmann R. and Vig, V. (2016), ‘The limits of model-based regulation’, ECB Working Paper Series No 1928, European Central Bank, Frankfurt.

Beltratti, A. and Paladino, G. (2016), ‘Basel II and regulatory arbitrage: Evidence from financial crises’, *Journal of Empirical Finance*, Vol. 39, pp. 180–196.

Bruno, B., Nocera, G. and Resti, A. (2016), ‘Are risk-based capital requirements detrimental to corporate lending? Evidence from Europe’, CEPR Discussion Paper No 12007, Centre for Economic Policy Research, London.

Cannata, F., Casellina, S. and Guidi, G. (2012), ‘Inside the labyrinth of Basel risk-weighted assets: How not to get lost’, *Questioni di Economia e Finanza* No 132, Banca d’Italia, Rome.

Dietsch M. and Fraisse H., (2013). *How different is the regulatory capital from the economic capital: the case of business loans portfolios held by the major banking groups in France*. Débats économiques et financiers

Döme, S. and Kerbl, S. (2017), ‘Comparability of Basel risk weights in the EU banking sector’, *Financial Stability Report*, issue 34, pp. 68–89, Oesterreichische Nationalbank, Vienna.

EBA (2013), *Interim results update of the EBA review of the consistency of risk-weighted assets*, European Banking Authority, London.

EBA (2017), *EBA Report on IRB modelling practices*, European Banking Authority, London.

EBA (2018), *Results from the 2018 low and high default portfolios exercise*, European Banking Authority, London.

EBA (2019), *Results from the 2019 low-default and high-default portfolios exercise*, European Banking Authority, Paris.

Lindley D. V., (2013), *Understanding Uncertainty*. Wiley

Mariathasan, M. and Merrouche, O. (2014), ‘The manipulation of Basel risk weights’, *Journal of Financial Intermediation*, Vol. 23, pp. 300–321.

Plosser, M. C. and Santos, J. (2014), 'Banks’ incentives and the quality of internal risk models’, Federal Reserve Bank of New York Staff Reports No 704, Federal Reserve Bank of New York, New York.

F. Hagendorff, J. and Vallascas, (2013), ‘The risk sensitivity of capital requirements: Evidence from an international sample of large banks’, *Review of Finance*, Vol. 17, No 6, pp. 1947–1988.

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