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Valuation Risk at European Banks: Empirical Evidence

A Whitepaper

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Table of Contents

About Promontory

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Promontory's clients include the largest 50 financial institutions globally, the largest 50 financial institutions in the U.S., the top 10 banks and largest insurers in Europe, the four largest financial institutions in Australia, the three largest financial institutions in Japan, and the largest financial institution in China. They also include the largest central banks and regulatory agencies in the U.S, Europe, Canada, Japan, U.K., and Australia.

Our unique domain expertise, combined with IBM's world-class technology and business transformation capabilities allow us to resolve challenging national and cross-border issues in banking, insurance, securities, commodities, financial instruments, and capital markets. Promontory professionals bring to bear their broad and deep experience gained from decades of leadership at Fortune 100 corporations and regulatory authorities. Our ability to combine the expertise of former senior financial services executives and regulatory officials — including from several agencies that regulate benchmarking participants — sets us apart from other consulting firms.

Introduction

The risk that a financial institution will experience a loss because it did not accurately determine the fair value of the financial instruments on its balance sheet is known as Valuation Risk (VR). That risk is sometimes heightened because determining fair value is not always a simple or straightforward task.

Regulations show that supervisors prefer fair value to be determined through observable inputs such as objective market data. But sometimes market data is thin or unavailable, or markets turn illiquid. In these instances, banks can rely upon internally developed valuation models that use unobservable inputs, provided they constitute the best available information under the circumstances. However, internally developed models based on unobservable inputs amplify VR, as do financial instruments with complex features and limited liquidity.

VR has attracted growing supervisory attention. Several supervisory agencies internationally have voiced concern over banks holding vast amounts of instruments that are potentially exposed to valuation uncertainty[1] and the potential knock-on effects this VR could have on the stability of the financial system.

In our effort to contribute to this issue, we set out to analyze European banks' exposure to the risk that some financial instruments on banks' balance sheets may not be valued accurately. In our previous Promontory whitepaper, "Valuation Risk — A Holistic Accounting and Prudential Approach" [1], we addressed banks' VR from a comprehensive perspective that encompassed methodology, governance, as well as the accounting and prudential regulations and their interaction.

This whitepaper seeks to expand the analysis by investigating European banks' exposure to VR from a more quantitative perspective. To this end, we collected the evidence available from banks' disclosures, looked for patterns, and drew as many sound conclusions as possible.

We initially intended for our analysis to include three quantitative exercises:

1. A static analysis of banks' balance sheet data with a focus on the holdings of instruments most exposed to VR
2. A high-level scenario analysis aimed at inferring some conclusions on the impact that a possible shock on risk factors, used in the evaluation process, might generate on banks' capitalization and resilience
3. A review of the analysis disclosed by the banks about the sensitivity of the value of their financial instruments most exposed to valuation risk (i.e., those classified as Level 3 in the Fair Value Hierarchy[2]) to changes in the unobservable inputs used for their valuation. The aim was to understand whether and to what extent banks factor the results of that analysis into their prudential capital calculation

However, in doing so, we encountered a frustrating reality: inadequacies in available data make it difficult to build an accurate view of these risks.

Severe limitations in the availability of data posed obstacles to all of the above exercises. We could only execute the first exercise — static analysis — and inferred some general, high-level, albeit interesting, conclusions, with no definitive evidence about the individual banks' actual VR exposure.

We were forced to dismiss the second and third planned exercises altogether. For the scenario analysis, we found the assumptions required to manage data limitations were too significant and pervasive to reach any conclusions with an acceptable degree of reliability. For the sensitivity analysis review, the lack of information was profound. Not only we could not execute a consistent analysis of data across banks, but more importantly, we were not in a position to understand whether banks had leveraged the results of that analysis for prudential capital calculation and, if so, whether they did so in relation to the market risk framework or the VR framework.

1. As recently as in February 2020 [6], the European Systemic Risk Board (ESRB) warned that: "Financial instruments that are held by banks for trading purposes and measured at fair value (some of which — like derivatives and relatively illiquid instruments — are classified in Levels 2 and 3 of the Fair Value Hierarchy) may be subject to sharp corrections and reassessments of their risk premia, which could trigger large adjustments to fair values. This is particularly relevant in the current macro-financial environment, where the repricing of risk premia is estimated to be a source of systemic risk for the EU financial system." In a 2017 report [5], the Basel Committee for Banking Supervision (BCBS) pointed to the discretion left by the accounting rules in the determination of the fair value of financial instruments by noting that: "The crisis showed that accounting values may embed a significant degree of uncertainty and, as a result, may impede the market's ability to assess a bank's risk profile and overall capital adequacy. [...] The evidence consistent with accounting discretion as contributing to moral hazard behavior indicates that (additional) prudential valuation requirements may be justified."
2. Please see Chapter 2 of our previous whitepaper [1] for details: https://www.promontory.com:3000/static/pdf/1604424516_valuation_risk_whitepaper.pdf.

As we've noted, encountering these limitations was frustrating. But obstacles like this pose a choice: give up, or forge ahead in a new direction.

We had to narrow the range of the analysis that we could reasonably perform, confirming our argument in the previous whitepaper that the amount of disclosure required of banks by current regulations is insufficient. The data is not robust enough to enable external analysts and observers to reliably estimate how much risk is embedded in bank balance sheets stemming from uncertainty over fair value instrument valuation.

We realized that the lack of data itself is an important lesson, as it informs us that crucial information is missing in banks' disclosure. This paper delivers the results of the narrower analysis allowed by the limited data and delves into the implication of these constraints.

The lack of data thwarts efforts to build an accurate view of the risks truly resting on financial institutions' balance sheets. This is a serious matter. European banks hold assets and liabilities potentially exposed to amounts of VR that may exceed their regulatory capital by many multiples. Even a relatively small unexpected shock or estimation error in instrument valuations could significantly impact banks' capitalization and resilience.

In the debate over VR, we believe a joint action by supervisors and standard setters to deepen banks' disclosure of their holdings of assets and liabilities potentially more exposed to VR[3] would significantly increase transparency and risk-awareness in the financial industry.

By increasing clarity and transparency around bank risks through increased disclosure, banks can enhance public trust and allow observers and analysts to better assess bank balance sheets, leading to share prices that more closely reflect bank risks.

This whitepaper is organized as follows:

- Section 1 focuses on the static analysis of banks' balance sheet data, with a focus on the holdings of instruments more exposed to VR
- Section 2 illustrates the limitations we encountered in data availability and discusses their impact on our work as well as their implications for the transparency of banks' risk exposures

3. Namely, those classified in Levels 2 and 3 of the Fair Value Hierarchy.

1. Static Analysis of EU Banks' Balance Sheet Data

This section illustrates the results of our empirical analysis to investigate the exposure of European banks to VR at both the aggregate and the individual level.

Our analysis has yielded interesting evidence, as summarized in this section. We present the conclusions that are allowed by the numbers and discuss the data's limitations, which prevent us from drawing further conclusions.

In performing our analysis, we faced significant limitations in the availability of relevant information including, but not limited to, banks' governance arrangements around instrument valuations, unobservable inputs considered in banks' pricing models, the significance of such inputs for instrument valuation, the exposure of banks' liabilities to VR and its correlation to assets. The limitations in data availability are illustrated in more detail in Section 2.

As a result of such issues, the analysis can only provide high-level, preliminary indications about banks' exposures to VR. In particular, it does not justify any firm conclusion about individual banks' situation in this respect.

We believe that an effort by supervisors and standard-setters to enhance the set of information that banks are required to disclose would facilitate more accurate estimations of risks in the banking industry.

1.1. Methodology

Banks' exposure to VR stems from the uncertainty regarding the valuation of their instruments measured at fair value in the financial statements. While all such instruments are exposed to VR in concept, their level of exposure depends on the level of the Fair Value Hierarchy in which they are classified. The exposure tends to be low for Level 1 (L1), higher for Level 2 (L2), and highest for Level 3 (L3) instruments.[4]

We have focused on the amount of assets in banks' balance sheets that are more likely to be exposed to valuation inaccuracy, i.e., assets classified as L2 and L3. These amounts are publicly known as banks are required to disclose the amount of their instruments classified in each level of the Fair Value Hierarchy.

We have considered a set of metrics for each bank to undertake our analysis, as summarized here below. The detailed description of these metrics and their economic interpretation concerning VR are described in section 1.1.3, while their values for the individual banks are shown in tables 4, 5, and 6.

The metrics considered include:

- The CET1 ratio, i.e., the ratio of Common Equity Tier 1 (CET1) capital to Risk-Weighted Assets (RWA), is a measure of a bank's resiliency against possible future losses.
- The ratios of L2 and L3 asset holdings to CET1 capital. This relationship provides a measure of the potential impact of a shock on L2 or L3 instrument prices due to valuation uncertainty in terms of banks' capitalization and resilience. We have separately analyzed the ratio of the sum of L2 and L3 assets to CET1 and the ratio of L3 assets to CET1.
- The ratio of Total Assets Marked at Fair Value to Total Assets, which indicates the proportion of the assets potentially exposed to VR (i.e., those marked at fair value) with respect to the total of assets, i.e., all assets in the balance sheet either marked at fair value or not.
- The ratio of Sum of L2 and L3 Assets to Total Assets, which indicates the share of the assets that are more likely to be exposed to VR with respect to the Total Assets.
- The ratio of L3 Assets to Total Assets, which is similar to the ratios described in the previous bullet points, except that the numerator is replaced by the amount of L3 assets only, i.e., the assets that are most likely to be exposed to high VR.

4. Ibid., pages 1, 22 and 26

1.1.1. DATA COLLECTION

We drew the data for our analysis from the European Banking Authority (EBA)'s EU-wide Transparency Exercise,[5] which aims to foster transparency and market discipline in the EU financial market and complements banks' own Pillar 3 disclosure [2]. The EBA Transparency Exercise covers 127 European banks, either supervised under the Single Supervisory Mechanism (SSM) or not.

The EBA Transparency Exercise provides clear, structured, and accessible financial data and prudential metrics for all banks within its scope, including detailed bank-by-bank data covering assets and liabilities, capital positions, risk exposure amounts, leverage exposures, and other data.

The EBA has executed this exercise annually since 2011, allowing the authority to progressively increase the amount of published data over the years. Information about banks' assets measured at fair value has been included in the EBA dataset since September 2018. Unless stated otherwise, the data presented is taken from the most recently available EBA publication, dated June 2020.

Notably, the EBA dataset includes the split of banks' assets by level in the Fair Value Hierarchy, but not that of liabilities, although liabilities are likely to contribute significantly to banks' overall VR exposures. In our opinion, the EBA's effort to add the distribution of banks' liabilities by Fair Value Hierarchy level would be welcome as it would facilitate the assessment of banks' risk exposures by external analysts.

1.1.2. CLUSTERING

For our analysis, we have clustered the banks covered by the EBA Transparency Exercise into four groups based on total assets:

- **Cluster 1:** banks with total assets above €500bn (19 banks)
- **Cluster 2:** banks with total assets between €100bn and €500bn (30 banks)
- **Cluster 3:** banks with total assets between €50bn and €100bn (24 banks)[6]
- **Cluster 4:** banks with total assets below €50bn (54 banks)

We have considered the banks in Clusters 1 to 3 in our analysis. We have left Cluster 4 out of scope because, in our experience, holdings of financial instruments with "weird" or "non-standard" characteristics by relatively small banks are unlikely to be material, and they tend to contribute little to VR at a systemic level.

In addition to the banks mentioned above, the EBA groups under an item named "Other Banks" 25 European branches of global banks have their headquarters in the USA or Asia-Pacific areas. However, the values for these branches are provided as an aggregate, and thus no specific bank-by-bank ratio could be calculated. We have considered these banks as out of scope for our analysis.

The table below shows the absolute size of some aggregated metrics for the banks of the three clusters in scope of our analysis.

Table 1: Selected metrics by cluster. Aggregated absolute values as of 30 June, 2020.[7]

ID	METRIC	CLUSTER 1	CLUSTER 2	CLUSTER 3
		EU BANKS WITH TOTAL ASSETS ABOVE €500 BN (€ BN)	EU BANKS WITH TOTAL ASSETS BETWEEN €100 AND 500 BN (€ BN)	EU BANKS WITH TOTAL ASSETS BETWEEN €100 AND 500 BN (€ BN)
1	CET1 Capital	986.4	344.1	140.1
2	Total Assets at Fair Value / Total Assets	6,348.5	1,372.1	284.0
3	Total L2+L3 Assets	4,476.0	914.2	146.9
4	Total L3 Assets	170.8	40.0	39.5

5. The data has been retrieved from the EBA Website: https://eba.europa.eu/risk-analysis-and-data/eu-wide-transparency-exercise.
6. Two banks have been excluded from the sample since they didn't report the figures of Total Assets on December 2019. This is the date considered to define the clusters since the figures reported for the liabilities are also gathered on the same date. Moreover, the bank #18 was added to cluster 1 and removed from cluster 2, the bank #49 was added to cluster 2 and removed from cluster 3, the bank #71 was added to cluster 3 and removed from cluster 4. These minor adjustments were considered since we had analyzed the criteria of the classification of each bank into the clusters also over a longer time horizon.
7. The data reported in this table and in the following tables and figures are rounded.

The figures in Table 1 provide a first-glance indication of the massive size of the instruments potentially subject to VR. The total of L2 and L3 assets for the banks of the three clusters amounts to approximately €5.5 trillion as of June 2020. To this amount, liabilities measured at fair value and classified L2 or L3 should be added, as they can also be potentially exposed to VR. However, as will be illustrated later, it is not possible to infer from publicly disclosed data the extent to which liabilities mitigate VR exposures or rather contribute to them. Unfortunately, the EBA Transparency Exercise does not provide the amount of liabilities split by the Fair Value Hierarchy level. Nevertheless, to provide an order of magnitude of this additional layer of potential VR, we mined Cluster 1 banks' financial reports (latest available data as of 31 December 2019) of for the amounts of L2 and L3 liabilities. For these banks, the holdings of liabilities measured at fair value are shown in the following table.

Table 2: European banks with total assets above €500 billion (Cluster 1) — liabilities measured at fair value by level in the Fair Value Hierarchy. Aggregated amounts as of 31 December 2019.

METRIC	LEVEL 1 (€ BN)	LEVEL 2 (€ BN)	LEVEL 3 (€ BN)	TOTAL (€ BN)
Total Liabilities at FV	379.5	3,442.6	134.6	3,956.7

It is worth noting that L2 and L3 liabilities reach significant amounts, not far from assets. It is apparent that, given such large amounts, even small errors in valuations or control failures, such as hedging practices that overstate liabilities' ability to mitigate valuation risks, can have systemic impacts, as supervisors have warned.[8]

1.1.3. METRICS

The EBA dataset includes a significant amount of data from the European banks. We have used this data to build a set of metrics significant for our analysis:

1. **Ratio of CET1 to RWA (CET1 Ratio):** this measure compares a bank's Common Equity Tier 1 capital to its Risk-Weighted Assets (RWA). The current minimum capital requirements defined under the Capital Requirements Regulation (CRR [3]), which are all indicated in terms of ratios to RWA, are:
   - CET1: 4.5%
   - Tier 1: 6%
   - Common Equity: 8%
   - Capital Conservation Buffer (CCB): 2.5%
   - Countercyclical Capital Buffer (CCyB): up to 2.5%[9]

   Considering the sum of the components defined above, each bank has to hold capital that is at least between 10.5% and 13% of RWA, i.e., the sum of the Common Equity and the CCB, plus the CCyB as defined by each bank's local supervisor.)[10]
2. **Ratio of Total Assets Marked at Fair Value to Total Assets:** this measure indicates the proportion of the assets potentially exposed to VR[11] with respect to the total assets. The ratio's numerator is constructed as the sum of the following items in the EBA dataset: "Financial assets held for trading," "Non-trading financial assets mandatorily at fair value through profit or loss," "Financial assets designated at fair value through profit or loss," "Financial assets at fair value through other comprehensive income," and "Derivatives — Hedge accounting." The denominator corresponds to the item labeled "Total Assets."
3. **Ratio of Sum of L2 and L3 Assets to Total Assets:** the EBA Transparency Exercise reports for each bank the amount of assets marked at fair value classified in each of the three levels of the Fair Value Hierarchy. L2 assets generally make up for the largest part of assets marked at fair value. Therefore, this ratio is a measure of the share of banks' assets that are potentially exposed to VR.
4. **Ratio of Sum of L2 and L3 Assets to CET1:** the ratio of L2 and L3 assets on CET1 is a significant metric given the impact that a shock on asset fair values due to valuation uncertainty could have on banks' regulatory capital and resilience.

8. Please see Footnote 1.
9. These are defined by local regulators on a quarterly basis.
10. It is worth noting that, pursuant to guidance from the Supervisors, banks may use the Countercyclical Capital Buffer to cope with the impact of COVID-19.
11. I.e., those marked at fair value.

5. **Ratio of L3 Assets to Total Assets:** this ratio is similar to ratio #3, except with the numerator replaced by the amount of L3 assets only, i.e., the assets that are more likely to be exposed to VR.
6. **Ratio of L3 Assets to CET1:** this ratio is similar to ratio #4, except with the numerator replaced by the amount of L3 assets only. It shows the amount of L3 assets in each bank's portfolio in comparison to its CET1. Because L3 assets are most exposed to VR, an unanticipated or unforeseen strong shock to their fair values due to valuation uncertainty could precipitate a considerable impact on CET1 even when the L3 asset portfolio is relatively small.

The following table shows the minimum, maximum, and simple average values of the above metrics in each of the three clusters.

Table 3: Selected metrics — minimum, simple average, and maximum values by cluster as of 30 June 2020.

ID	METRIC	CLUSTER 1	CLUSTER 2	CLUSTER 3
		EU BANKS WITH TOTAL ASSETS ABOVE €500 BN (%)	EU BANKS WITH TOTAL ASSETS BETWEEN €100 AND 500 BN (%)	EU BANKS WITH TOTAL ASSETS BETWEEN €100 AND 500 BN (%)
1	CET1 Capital	[11.2 : 14.2 : 17.6]	[11.4 : 16.4 : 32.4]	[11.0 : 15.9 : 30.1]
2	Total Assets at Fair Value / Total Assets	[8.2 : 27.1 : 47.7]	[4.5 : 18.2 : 90.9]	[2.4 : 15.8 : 69.3]
3	Total L2+L3 Assets / Total Assets	[5.0 : 19.2 : 41.5]	[1.2 : 11.84 : 88.5]	[0.4 : 8.4 : 60.1]
4	Total L3 Assets / Total Assets	[0.3 : 0.7 : 1.74]	[0.04 : 0.73 : 4.9]	[0.0 : 1.8 : 17.5]
5	Total L2+L3 Assets / CET1 Capital	[82.0 : 469.3 : 1263.9]	[20.9 : 264.6 : 1814.9]	[3.9 : 149.3 : 1225.9]
6	Total L3 Assets / CET1 Capital	[6.5 : 17.7 : 55.7]	[0.9 : 15.2 : 96.0]	[0.0 : 32.1 : 326.5]

The ratios in Table 3 for the individual clusters should be analyzed with caution, as they could be affected by outliers that reduce the representativeness of the overall figures.

The analysis presented in the following sections, focusing on the individual banks within each cluster, supports a deeper dive into the data by highlighting the impact of outliers on the cluster-level metrics.

The detailed analysis allows confirming some general observations that can be drawn from Table 3, namely that the largest banks (Cluster 1) are, on average, less capitalized than those of the other clusters (as shown by the CET1 Ratio) and at the same time present a higher propensity to invest in instruments potentially exposed to VR, as suggested by the higher levels of the metrics numbered 2, 3, and 5.

Metrics 4 and 6 suggest that the banks in Cluster 3 have a higher propensity to invest in L3 instruments. However, this conclusion is not confirmed by the detailed analysis, which shows that the average metrics for Cluster 3 are heavily affected by some outliers.

1.2. Cluster 1: EU Banks with Total Assets Exceeding €500 Billion

1.2.1. METRICS

Below are the metrics that we have analyzed for Cluster 1 banks, ordered by total assets in the portfolio. As mentioned above, all data refers to assets only and does not include liabilities.[12]

Table 4: Metrics for Cluster 1 banks as of June 30, 2020.

BANK IDENTIFIER	TOTAL ASSETS (€ BN)	L3 ASSETS (€ BN)	L2+L3 ASSETS (€ BN)	CET1 CAPITAL (€ BN)	CET1 RATIO (%)	L3 ASSETS/ TOTAL ASSETS (%)	L2+L3 ASSETS/ TOTAL ASSETS (%)	L3 ASSETS/ CET1 CAPITAL (%)	L2+L3 ASSETS/ CET1 CAPITAL (%)
# 1	2,519.5	12.4	421.5	114.7	14.9	0.5	16.7	10.8	367.5
# 2	2,387.4	14.6	639.8	86.0	12.2	0.6	26.8	16.9	744.4
# 3	1,826.1	11.0	278.7	93.2	16.0	0.6	15.3	11.8	299.1
# 4	1,556.3	8.7	216.9	67.2	11.5	0.6	13.9	12.9	322.8
# 5	1,515.9	22.6	628.6	49.7	13.5	1.5	41.5	45.4	1263.9
# 6	1,407.3	24.4	531.9	43.9	13.2	1.7	37.8	55.7	1212.6
# 7	1,319.0	14.6	169.3	66.1	15.3	1.1	12.8	22.2	256.2
# 8	1,303.8	15.9	370.8	44.5	12.3	1.2	28.4	35.6	833.0
# 9	984.8	4.9	104.3	48.2	14.9	0.5	10.6	10.1	216.2
# 10	893.1	5.0	80.4	51.0	13.9	0.6	9.0	9.8	157.7
# 11	883.8	2.8	261.5	34.2	16.3	0.3	29.6	8.0	764.9
# 12	846.1	8.4	42.6	52.0	17.6	1.0	5.0	16.2	82.0
# 13	784.7	5.8	66.8	33.1	13.4	0.7	8.5	17.6	202.0
# 14	734.2	3.2	103.9	42.1	11.2	0.4	14.2	7.6	246.7
# 15	691.1	3.7	50.4	43.3	13.8	0.5	7.3	8.5	116.6
# 16	662.2	2.2	177.1	33.6	14.2	0.3	26.7	6.5	527.0
# 17	620.1	2.3	34.5	34.2	16.6	0.4	5.6	6.7	100.8
# 18	550.6	4.3	105.7	25.1	13.4	0.8	19.2	17.3	421.8
# 19	543.6	4.1	191.3	24.5	15.8	0.8	35.2	16.7	782.2

12. Specific names of the banks corresponding to the number identifier reported in the table are available from the authors upon request.

1.2.2. L3 ASSETS HOLDINGS

The following chart focuses on holdings of L3 assets by the banks of this cluster.

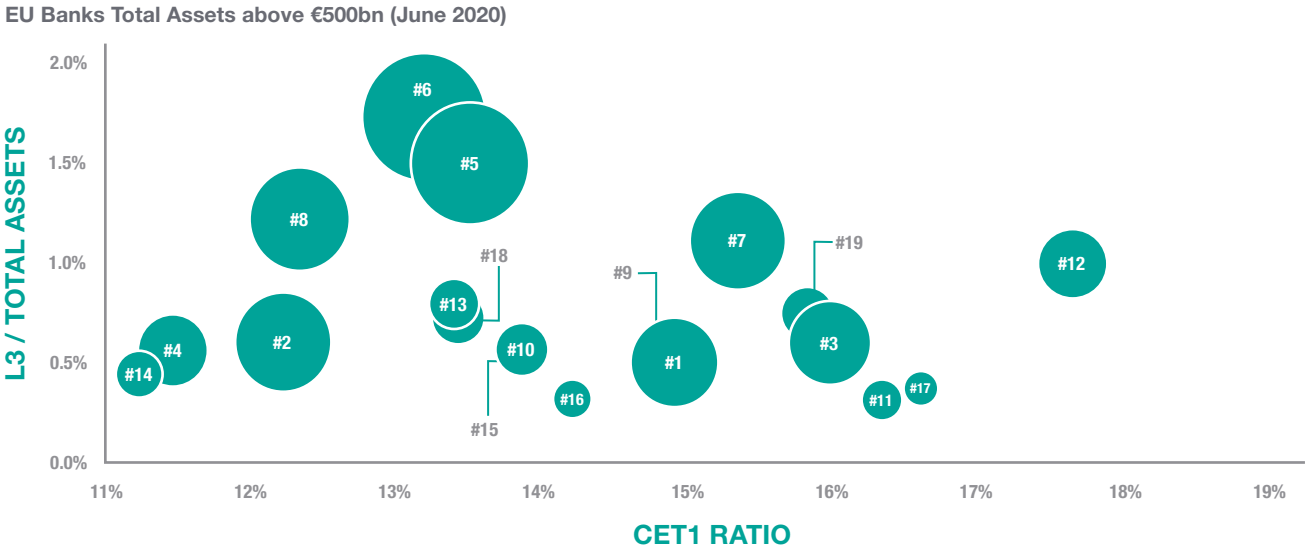

Figure 1: EU Banks with total assets exceeding €500 billion, 30 June 2020 — ratio of L3 assets to total assets versus CET1 ratio.

Each bubble represents a bank. The label beside each bubble is the unique bank identifier used in Table 4.

- Y axis: ratio of L3 assets to total assets
- X axis: CET1 ratio
- The bubble size is proportional to the absolute amount of L3 assets held by the relevant bank

The chart provides the following indications for the banks in this cluster:

- The y axis shows the ratio of L3 assets as a share of total assets. Because L3 assets are most likely to be exposed to VR, the higher a bank is on the y axis, the greater is its potential exposure to VR. L3 assets account for a limited share of total assets, ranging from 0.5% to 2%, with the banks labeled #5 and #6 (see Table 4 for reference) presenting the highest ratio in the cluster.
- The x-axis shows each bank's CET1 ratio. The farther right a bank is located on the diagram, the higher the level of capital it holds to cover its risks. The CET1 ratio for the banks in the cluster ranges from slightly more than 11% (Bank #14) to close to 18% (Bank #12). The chart does not reveal any clear relationship between the ratio of L3 assets as a share of total assets and the level of capitalization.
- The bubble size is proportional to the absolute amount of L3 assets in each bank's portfolio. The bubble sizes illustrate significant differences in the L3 portfolios held by different banks. This may be a direct reflection of size, as larger banks are expected to hold larger portfolios. However, we note that the banks with the largest L3 portfolios (i.e., the biggest bubbles — banks #5 and #6) are not necessarily those with the largest overall asset portfolios, as shown in Table 4. On the other hand, banks # 5 and #6 are also highest on the y axis. This means that for these banks, the size of L3 assets portfolio does not only reflect the size of the bank as measured by total asset but also the higher propensity of these banks to invest in L3 assets compared to their peers in the cluster, as shown by a higher ratio of L3 assets as a share of total assets.
- We believe there is valuable information in the chart in relation to each bank's ratio of L3 assets to CET1, which is reported in Table 4 under the column L3/CET1. This ratio is also a measure (in percentage) of the potential impact on CET1 of a 1% shock on L3 asset prices. This number is significant for most banks. It is set at 45% and 56%, respectively, for the two banks (#5 and #6), showing the highest incidence of L3 assets as a share of total assets and exceeding 20% for several others. This evidence suggests that L3 instruments, despite representing a small portion of total assets, are by no means immaterial to the potential impact of a possible price shock or valuation error on regulatory capital.[13]

[13] The actual risk exposure of each bank may be relieved by the possible offsetting impact of L3 liabilities, which, as already mentioned, are not considered in this analysis

1.2.3. L2 + L3 ASSETS HOLDINGS

Figure 2 is similar to Figure 1, but with a broader focus targeting the sum of L2 and L3 instruments held by each bank in the cluster:

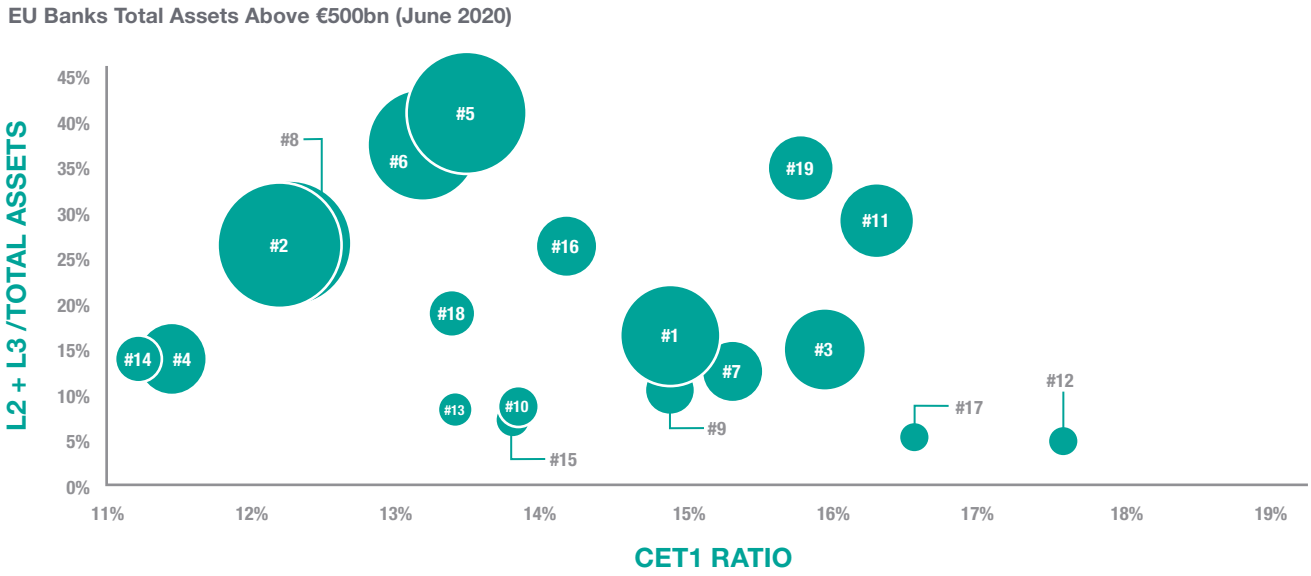

Figure 2: EU Banks with total assets exceeding €500 billion, 30 June 2020— ratio of (L2+L3) assets to total assets versus CET1 ratio.

Each bubble represents a bank. The label aside each bubble is the unique bank identifier used in Table 4

- Y axis: ratio of (L2+L3) assets to total assets
- X axis: CET1 ratio
- The bubble size is proportional to the absolute amount of (L2+L3) assets

In this figure:

- The y axis shows each bank's ratio of L2+L3 assets to Total Assets. Since L2 and L3 assets are likely to be exposed to VR, the higher a bank is on the y axis, the greater is its potential exposure to VR. However, it should be noted that this is only a high-level inference, as L2 instruments can bear diverse levels of exposure to VR. As L2 portfolios are bigger than L3 ones, the values on the y axis are higher than in Figure 1. They show a low of 5% (meaning that 95% of total assets are either not marked at fair value or allocated to L1 of the Fair Value Hierarchy) and exceed 20% in a substantial share of the cluster, reaching a high of 40% for the same two banks (#5 and #6) that we had identified in Figure 1 as those presenting the highest incidence of L3 assets as a share of total assets. It is worth noting that, to the extent that the classification of assets into L2 or L3 is a matter of judgment, the soundness and rigor of the governance of the fair value process[14] are particularly critical for the banks showing significant holdings of assets marked at fair value.
- As in Figure 1, the x axis shows each bank's CET1 ratio. Similar to our observation related to Figure 1, we see no clear relationship between the ratio of L2+L3 assets as a share of total assets and the level of capitalization.
- With respect to the bubble size, which is proportional to the absolute amount of L2+L3 assets in each bank's portfolio, the chart shows a pattern similar to that already noted in Figure 1. Banks #5 and #6, which appeared in Figure 1 as those with the largest L3 asset holdings and the greatest share of L3 assets as a share of total assets, also present the largest L2+L3 asset portfolios, as represented by the size of the bubbles, and the highest proportion of L2+L3 portfolios on total assets, as shown by their position on the y axis. For these banks, the size of L2+L3 asset holdings reflects the bank's size (as measured by total assets) and is affected by a higher propensity to invest in L2+L3 assets compared to the other banks in the same cluster.

14. We also consider the framework and methodologies used for the allocation of assets in the appropriate level of the Fair Value Hierarchy to be part of the fair value process.

- Similarly to Figure 1, it is interesting to relate the information in the chart to the ratio of L2+L3 assets to CET1 shown in Table 4, which is also a measure of the potential impact of a 1% shock on L2 and L3 asset prices on CET1. This metric, which, not surprisingly, is highest for the banks that show the highest ratios of L2+L3 instruments on total assets exceeds five times (500%) in several cases, with two banks showing a high in excess of 12 times (1,200%). As mentioned above, we are not in a position to infer any firm conclusions about individual banks' actual exposure to VR due to insufficient information about the actual exposure of diverse L2 assets to VR and the possible risk-offsetting capacity of L2 and L3 liabilities. Nevertheless, the sheer size of these numbers makes it clear that a significant fraction of banks' risk exposure has the potential to dent significantly into their regulatory capital and remains hidden due to incomplete disclosure.
- The comparison of Figure 2 with Figure 1 reveals some patterns. While the banks with the highest proportion of L3 assets are also those with the highest proportion of L2+L3 assets, several banks (including bank #2, #11, #16, and #19) that rank relatively low by a proportion of L3 assets are instead high in the ranking of L2+L3 assets. However, we are not in a position to translate this observation into any meaningful conclusions in terms of the actual exposure of such banks to VR due to insufficiently detailed information.

1.3. Cluster 2: EU Banks with Total Assets Between €100 Billion and €500 Billion

1.3.1. METRICS

Below we report the metrics that we have analyzed for Cluster 2 banks, ordered by total assets in the portfolio. As mentioned above, all data refer to assets only and do not include liabilities.[15]

Table 5: Metrics for Cluster 2 banks as of 30 June 2020.

BANK IDENTIFIER	TOTAL ASSETS (€ BN)	L3 ASSETS (€ BN)	L2+L3 ASSETS (€ BN)	CET1 CAPITAL (€ BN)	CET1 RATIO (%)	L3 ASSETS/ TOTAL ASSETS (%)	L2+L3 ASSETS/ TOTAL ASSETS (%)	L3 ASSETS/ CET1 CAPITAL (%)	L2+L3 ASSETS/ CET1 CAPITAL (%)
# 20	494.0	3.2	77.0	21.3	14.0	0.6	15.6	15.2	366.1
# 21	470.5	0.4	213.0	18.5	17.3	0.1	45.3	2.0	1168.3
# 22	425.0	1.2	10.3	19.4	17.3	0.3	2.4	6.0	53.1
# 23	384.4	1.0	16.2	18.1	11.8	0.3	4.2	5.6	92.8
# 24	321.2	0.1	6.0	12.6	18.7	0.0	1.9	0.9	47.6
# 25	298.7	0.7	12.7	15.0	17.3	0.2	4.2	4.5	84.6
# 26	287.4	0.9	52.0	12.0	14.2	0.3	18.1	7.7	436.3
# 27	287.3	0.2	6.9	11.9	32.4	0.1	2.4	1.4	58.8
# 28	285.2	1.7	9.1	16.7	16.6	0.6	3.2	10.1	54.7
# 29	275.3	0.4	53.7	12.6	17.8	0.1	19.5	2.9	425.2
# 30	264.6	1.7	7.8	16.4	14.3	0.6	2.9	10.1	47.5
# 31	258.1	0.6	20.2	10.1	15.0	0.2	7.8	5.5	199.5
# 32	252.8	4.8	47.3	15.7	17.6	1.9	18.7	30.9	301.4
# 33	242.2	0.2	21.3	10.8	16.4	0.1	8.8	1.6	197.1
# 34	234.4	0.2	4.0	9.9	11.8	0.1	1.7	2.0	43.2
# 35	226.7	1.8	34.7	8.4	13.2	0.8	15.3	21.5	415.4
# 36	220.7	0.1	9.5	10.7	13.2	0.1	4.3	1.4	93.2
# 37	214.5	0.7	189.9	10.5	19.2	0.3	88.5	6.3	1814.9
# 38	179.3	1.3	5.1	9.5	13.1	0.7	2.8	15.3	58.9
# 39	171.1	3.1	17.0	8.8	15.5	1.8	9.9	35.1	193.1

15. See footnote 10.

BANK IDENTIFIER	TOTAL ASSETS (€ BN)	L3 ASSETS (€ BN)	L2+L3 ASSETS (€ BN)	CET1 CAPITAL (€ BN)	CET1 RATIO (%)	L3 ASSETS/ TOTAL ASSETS (%)	L2+L3 ASSETS/ TOTAL ASSETS (%)	L3 ASSETS/ CET1 CAPITAL (%)	L2+L3 ASSETS/ CET1 CAPITAL (%)
# 40	168.5	0.5	2.2	10.9	14.6	0.3	1.3	4.8	22.7
# 41	167.0	0.2	12.3	3.9	31.2	0.1	7.3	5.1	313.0
# 42	163.4	0.5	4.5	10.6	13.2	0.3	2.8	4.9	42.4
# 43	141.7	0.9	5.5	7.7	11.4	0.6	3.9	13.0	83.6
# 44	141.1	0.4	7.4	10.8	17.7	0.3	5.2	4.1	67.8
# 45	135.9	3.5	22.4	5.7	13.7	2.5	16.5	60.9	394.2
# 46	131.9	0.8	1.6	7.6	13.4	0.6	1.2	10.5	20.9
# 47	121.2	5.9	22.4	6.4	22.8	4.9	18.5	96.0	364.2
# 48	113.8	0.5	3.4	7.1	13.6	0.5	3.0	8.0	52.0
# 49	106.1	2.8	19.1	4.5	12.8	2.6	18.0	62.6	426.9

1.3.2. L3 ASSETS HOLDINGS

Figure 3 shows data about L3 assets for the banks in the cluster:

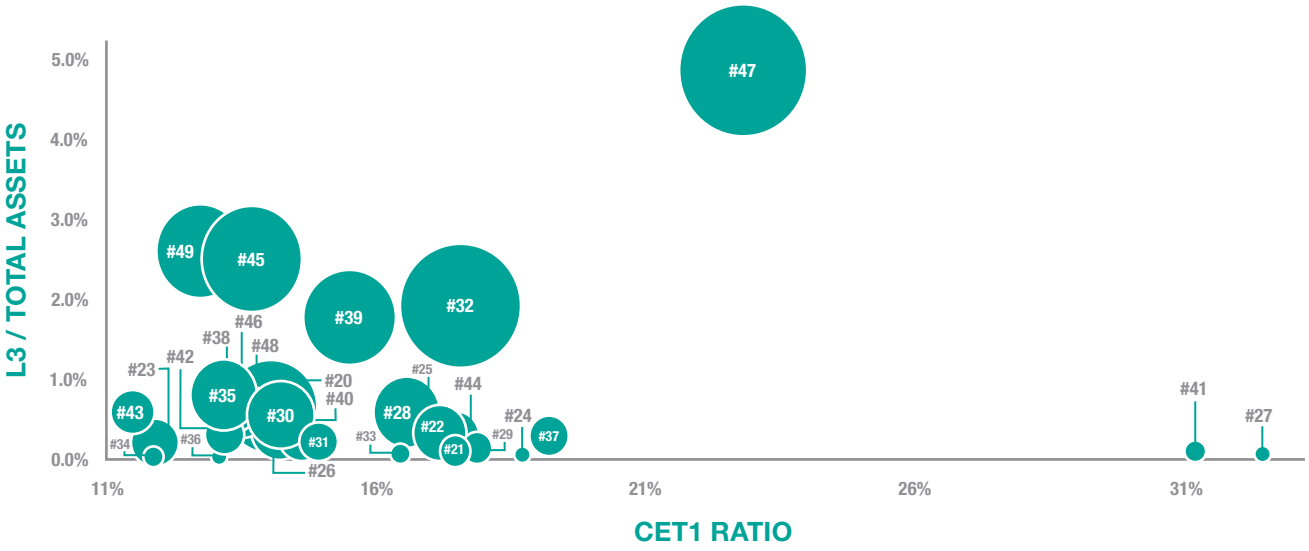

Figure 3: EU banks with total assets between €100 billion and €500 billion, 30 June 2020 — ratio of L3 assets to total assets versus CET1 ratio.

Each bubble represents a bank. The label aside each bubble is the unique bank identifier used in Table 5

- Y axis: ratio of L3 assets to total assets
- X axis: CET1 ratio
- The bubble size is proportional to the absolute amount of L3 assets

Figure 3 has the same structure as Figure 1 above. The following observations apply:

- Looking at the y axis, we note that several banks in this cluster show a higher propensity to invest in L3 instruments with respect to Cluster 1 banks, with a ratio of L3 assets to total assets exceeding 2% in five cases, with a high of 5% for bank #47.

- The x axis shows each bank's CET1 ratio. Banks with more capital to cover risks sit farther right in the diagram. The banks' capitalization ranges from 11% to 18% of most banks in the cluster, with two banks (#41 and #27) exceeding 30% and another (#47) above 20%. Once again, as in Cluster 1, we note no correlation between the propensity to invest in L3 assets, as represented by the level on the y axis and the CET1 ratio.
- The bubble size, which is proportional to the absolute amount of L3 assets in each bank's portfolio, shows a pattern similar to that identified for Cluster 1: Banks with the largest L3 portfolios do not correspond to the biggest banks in the cluster (as measured by the amount of total assets, represented in Table 5) and are consistently positioned highest on the y axis, i.e., they also present the most significant incidence of L3 portfolios on total assets. For Cluster 2, therefore, the amount of L3 instruments holdings is not only related to the size of the bank but is also affected by the propensity to invest in L3 assets compared to the other banks in the cluster.
- When comparing the information in Figure 3 to the ratio of L3 assets on CET1 shown in Table 5, we note that this ratio is highest for the five banks in the upper part of the chart (i.e., those with the highest ratios of L3 assets as a share of total assets), exceeding 60% in three cases with a high at 96%. As discussed above, this ratio is also a measure (in percentage) of the potential impact on CET1 of a 1% shock on L3 asset prices. Also, for Cluster 2 banks, we, therefore, observe that L3 exposures, despite representing a small portion of total assets, are by no means immaterial with respect to Tier 1, so that a shock on L3 assets can have a significant impact on Tier 1.[16]

1.3.3. L2 + L3 ASSETS HOLDINGS

Figure 4 below focuses on the total of L2 and L3 assets in banks' portfolios:

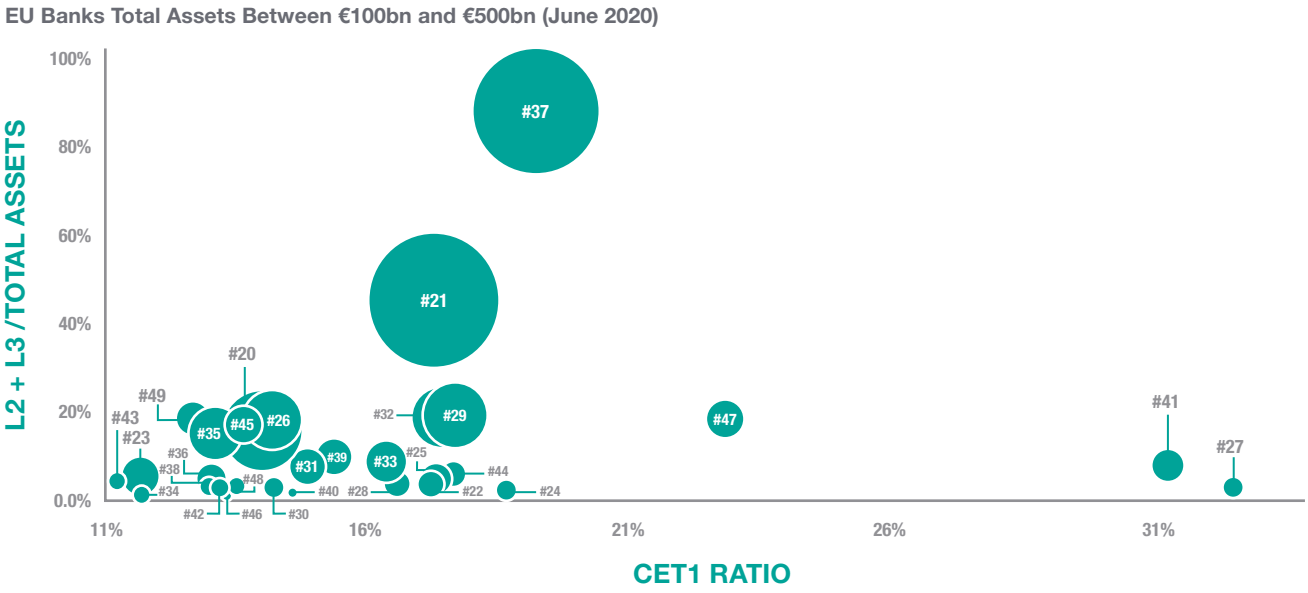

Figure 4: EU banks with total assets between €100 billion and €500 billion, 30 June 2020 — ratio of (L2+L3) assets to total assets versus CET1 ratio.

Each bubble represents a bank. The label aside each bubble is the unique bank identifier used in Table 5.

- Y axis: ratio of (L2+L3) assets to total assets
- X axis: CET1 ratio
- The bubble size is proportional to the absolute amount of (L2+L3) assets

16. The actual risk exposure may be relieved by the possible offsetting impact of L3 liabilities, which as mentioned above are not considered in this analysis.

In this figure:

- The ratio of L2+L3 assets to Total Assets, represented on the y axis, does not exceed 20% for most banks in the cluster;[17] two banks (#37 and #21) show up as outliers with ratios respectively exceeding 80% and 40%.
- As in Figure 2, the x axis shows each bank's CET1 ratio Cluster 2 includes banks with a very high CET1 ratio, although most of them are located in the range between 11% and 18%. Once again, we can detect no significant relationship between banks' propensity to invest in L2 and L3 instruments[18] and their capitalization.
- The bubble size, which is proportional to the absolute amount of L2+L3 assets in each bank's portfolio, shows a less marked dispersion of the amounts of assets across the banks in the cluster with respect to Cluster 1, with the two exceptions noted above, i.e., banks #37 and #21, showing markedly larger L2+L3 asset holdings than any other in the cluster. At the same time, we note that, as in Cluster 1, the banks with the largest L2+L3 portfolios do not present the largest total asset holdings (as shown in Table 5) but do present the highest proportion of L2+L3 portfolios as a share of total assets. This once again shows that the holdings of L2+L3 assets are related to the size of the bank, as measured by total assets, and the propensity to invest in L2 and L3 instruments compared to peer banks.
- We have analyzed the relationship between the information in the chart and the ratio of L2+L3 assets to CET1 shown in Table 5, as this metric measures the potential impact on CET1 (in percentage) of a 1% shock on L3 asset prices. Banks #37 and #21, which show up as outliers in terms of the ratio of L2+L3 assets to Total Assets, also appear as outliers here, with L2+L3 assets respectively at around eighteen times (1,815%) and twelve times (1,168%) their CET1. In the other cases, this metric is generally lower than in Cluster 1, although significant in some cases with levels between three times and five times the CET1. We reiterate that each bank's actual risk exposure may be relieved by the possible offsetting impact of L3 liabilities, which, as already mentioned, are not considered in this analysis. Nevertheless, we argue that also for Cluster 2 banks, possible valuation errors on L2 and L3 assets can determine significant impacts on regulatory capital. Once again, the lack of information about the actual characteristics of L2 instruments and the risk mitigation capacity of L2 and L3 liabilities determines a significant shortfall in analysts' ability to accurately evaluate banks' risk exposures.
- The appearance of Figure 4 is significantly different than that of Figure 2. In fact, the banks with the highest share of L3 assets (as shown in Figure 2) do not coincide with those ranking highest in the share of L2+L3 assets. The opposite is also true: the two banks that appear as clear outliers in terms of the proportion of L2+L3 assets in their portfolios (Figure 4) show only a marginal weight of L3 assets, as per Figure 2.

17. Implying that at least 80% of total assets are either not marked at fair value or classified as L1 in the Fair Value Hierarchy.
18. The propensity to invest is represented by the position on the y axis.

1.4. Cluster 3: EU Banks with Total Assets Between €50 Billion and €100 Billion

1.4.1. METRICS

Below we report the metrics that we have analyzed for Cluster 3 banks, ranked by total assets in the portfolio. As mentioned above, all data refer to assets only and do not include liabilities.[19]

Table 6: Metrics for Cluster 3 banks as of 30 June 2020.

BANK IDENTIFIER	TOTAL ASSETS (€ BN)	L3 ASSETS (€ BN)	L2+L3 ASSETS (€ BN)	CET1 CAPITAL (€ BN)	CET1 RATIO (%)	L3 ASSETS/ TOTAL AS-SETS (%)	L2+L3 ASSETS/ TOTAL ASSETS (%)	L3 ASSETS/ CET1 CAPITAL (%)	L2+L3 ASSETS/ CET1 CAPITAL (%)
# 50	101.4	0.9	2.2	8.1	16.4	0.9	2.2	11.2	27.6
# 51	91.8	0.1	2.1	4.0	11.7	0.1	2.3	3.2	52.4
# 52	90.3	1.4	2.6	7.1	16.1	1.5	2.9	19.2	36.2
# 53	86.5	2.2	3.1	5.6	12.1	2.5	3.6	39.2	55.9
# 54	86.2	0.2	51.8	4.2	17.3	0.2	60.1	4.7	1225.9
# 55	85.9	0.6	1.4	4.1	12.2	0.7	1.7	15.3	35.2
# 56	84.2	2.0	6.5	8.2	16.6	2.4	7.8	24.2	80.0
# 57	83.1	14.5	14.7	8.7	16.8	17.5	17.7	166.9	168.5
# 58	82.7	0.6	0.9	6.3	19.6	0.8	1.1	10.2	14.1
# 59	78.9	1.0	4.3	6.2	14.5	1.3	5.5	16.3	70.1
# 60	77.8	4.9	10.6	1.5	30.1	6.3	13.6	326.5	703.6
# 61	71.3	0.2	8.1	4.2	11.8	0.2	11.3	4.0	192.9
# 62	68.1	0.4	1.9	6.5	14.4	0.5	2.8	5.7	29.2
# 63	67.0	0.1	2.7	4.6	11.0	0.1	4.1	2.1	59.3
# 64	64.4	0.2	1.0	4.9	11.5	0.3	1.5	4.0	20.1
# 65	63.5	0.3	0.5	5.0	16.6	0.5	0.8	6.0	9.6
# 66	62.4	0.2	0.8	3.3	14.3	0.3	1.3	6.3	24.8
# 67	61.3	0.2	2.6	5.4	12.8	0.4	4.2	4.3	47.2
# 68	60.7	0.5	3.8	2.7	15.8	0.8	6.3	17.2	138.3
# 69	60.6	0.2	9.1	8.6	19.8	0.3	15.0	2.3	106.2
# 70	57.0	-	0.2	5.5	15.7	0.0	0.4	0.0	3.9
# 71	41.8	0.7	7.6	4.1	21.7	1.7	18.2	17.5	184.1

[19] See footnote 10.

1.4.2. L3 ASSETS HOLDINGS

Figure 5 focuses on the holdings of L3 assets by Cluster 3 banks:

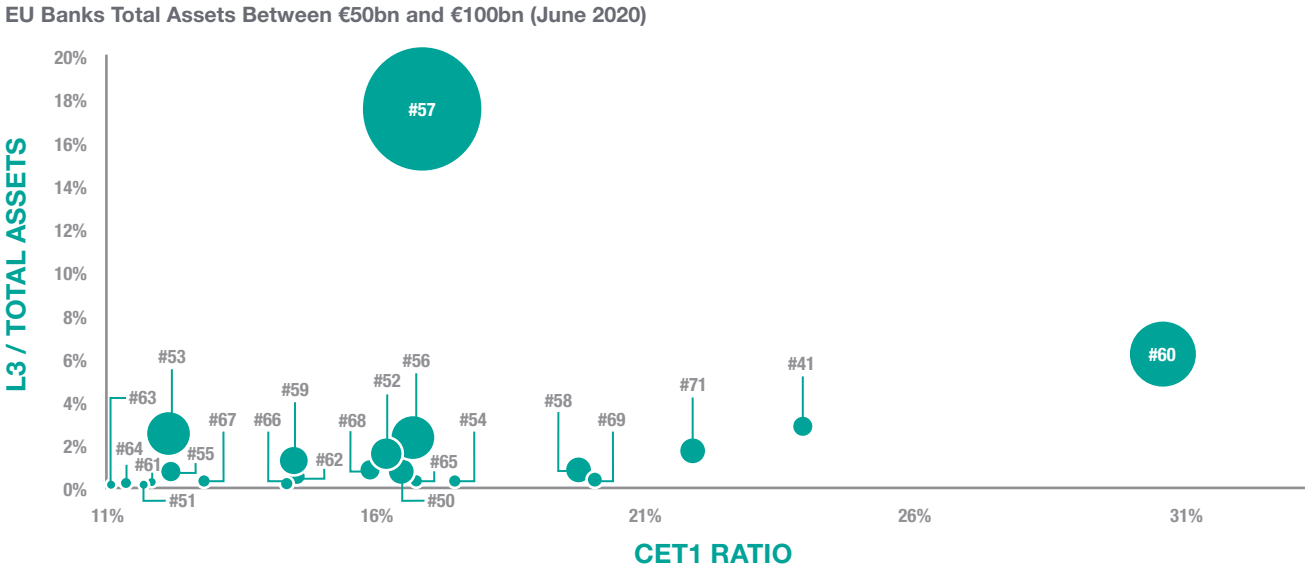

Figure 5: EU banks with total assets between €50 billion and $100 billion, 30 June 2020 — ratio of L3 assets to total assets versus CET1 ratio.

Each bubble represents a bank. The label aside each bubble is the unique bank identifier used in Table 6

- Y axis: ratio of L3 assets to total assets
- X axis: CET1 ratio
- The bubble size is proportional to the absolute amount of L3 assets

Figure 5 has the same structure as Figure 1 and Figure 3. The following observations apply:

- Looking at the y axis, we note two clear outliers (banks #57 and #60) with a ratio of L3 assets to total assets around 15% in one case and 6% in the other, largely exceeding any other bank in all the clusters. The remaining banks in Cluster 3 show ratios around or below 3%, in line with the other two clusters.
- Two banks with the largest amount of L3 assets (and the largest bubbles) stand out: #60 has a very high CET1 ratio of 24%, while #57 has a CET1 ratio in line with the rest of the cluster. In general, the banks in Cluster 3 show a level of dispersion of the CET1 ratio in line with Cluster 1 banks and lower than Cluster 2 banks. Once again, we see no apparent correlation between the propensity to invest in L3 assets and the CET1 ratio. The two above outlier banks also present a much greater amount of L3 assets than the other banks in the cluster, as implied by the bubble size. Once again, the banks that present the largest L3 asset portfolio do not coincide with the biggest banks in the cluster, as indicated by total assets (reported in Table 6), and are positioned highest on the y axis. For these banks, the size of the L3 asset portfolio is affected by a higher propensity to invest in L3 assets compared to their peers. For the other banks, the bubbles' size suggests a rather uniform amount of L3 assets throughout the cluster.
- If we relate the information in this chart with the ratio of L3 assets on CET1 shown in Table 6, we note that this ratio is very high for the two banks mentioned above, respectively, at 167% and 327%. As this figure measures the potential impact on CET1 of a 1% shock on L3 asset prices, it suggests that valuation errors or shocks to the value of L3 instruments may have a material impact on these banks' capital ratios.[20] As to the other banks in the cluster, one presents a ratio above 30% while others show 18% or lower.

[20] L3 liabilities, which may significantly mitigate the risk, are not considered in this exercise.

1.4.3. L2 + L3 ASSETS HOLDINGS

Figure 6 focuses on the sum of L2 and L3 instruments in the portfolios of Cluster 3 banks:

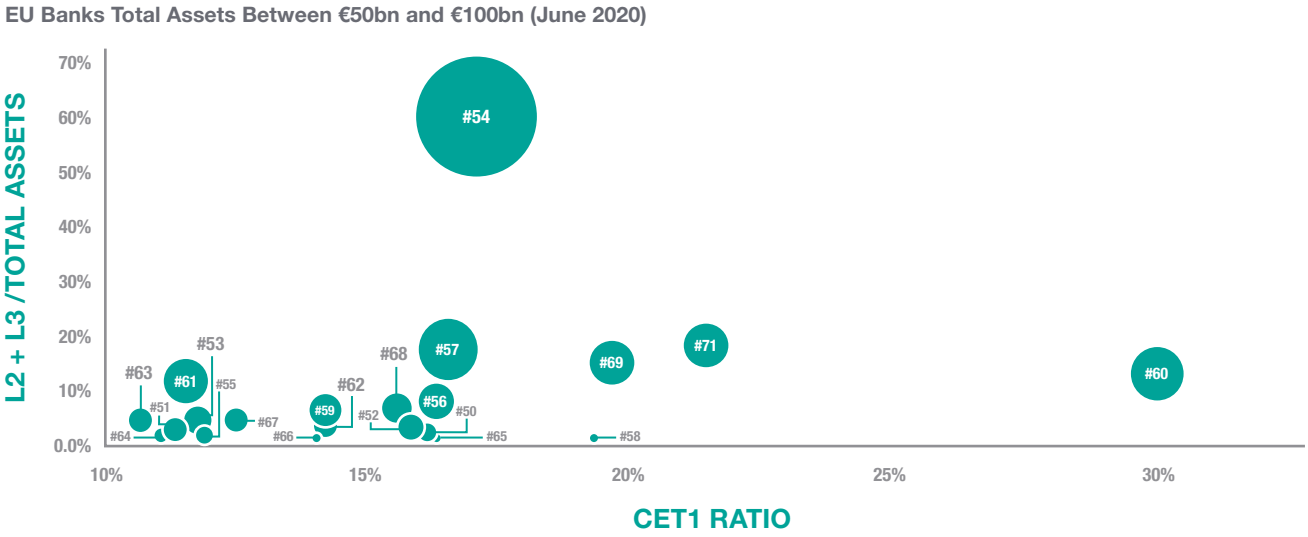

Figure 6: EU banks with total assets between €50 billion and €100 billion, 30 June 2020 — ratio of (L2+L3) assets to total assets versus CET1 ratio.

Each bubble represents a bank. The label aside each bubble is the unique bank identifier used in Table 6

- Y axis: ratio of (L2+L3) assets to total assets
- X axis: CET1 ratio
- The bubble size is proportional to the absolute amount of (L2+L3) assets

The following observations apply:

- Bank #54 shows up as a clear outlier in terms of ratio of L2+L3 assets to total assets (y axis) with around 60%. As shown by Figure 5, this bank has only a minimal amount of L3 assets and is therefore concentrated on L2 assets. At the same time, the two banks that appeared as outliers concerning L3 investments (#57 and #60) are found much closer to the cluster average when L2 assets are added to the picture. The remaining banks in the cluster show a general, lower weight of L2 and L3 assets compared to the preceding two clusters (20% or less), suggesting that the vast majority of their assets are either allocated to L1 in the Fair Value Hierarchy or are not marked at fair value in their balance sheets. This suggests that the propensity to invest in "less traditional" products is inversely related to banks' size. This is consistent with the assumption that the practice of investing in "exotic" instruments implies matching complex governance and control requirements, whose cost may not be justified in smaller banks.
- No significant relationship between banks' propensity to invest in L2 and L3 instruments (represented by the position on the y axis) and their capitalization has been detected.
- Looking at the amount of L2+L3 assets, represented by the bubble size, we note two outliers, of which one (#54) is also an outlier for the ratio of L2+L3 assets as a share of total assets and the other (#57) is an outlier for the share of L3 assets as a share of total assets. The other banks in the cluster show a rather similar size of L2+L3 portfolios.
- If we look at the ratio of L2+L3 assets to CET1, represented in Table 6, we note that two of the banks identified as outliers under the previous bullet points (#54 and #60) also show up as exceptions here with portfolios of L2+L3 assets at respectively twelve times and seven times their CET1, in line with some of the highest levels encountered in Cluster 1. We recall that this ratio measures the potential impact on CET1 (in percentage) of a 1% shock on L2 and L3 asset prices.[21] As previously observed, the lack of sufficient disclosure about the characteristics of L2 assets and the risk offsetting capacity of L2 and L3 liabilities makes it difficult to infer a reliable estimate of the actual risk exposure of these banks. For the remaining banks in the cluster, the ratio of L2+L3 assets to CET1 is significantly lower than Clusters 1 and 2, being below 200% in most cases.

21. The actual risk exposure of each bank may be relieved by the possible offsetting impact of L3 liabilities, which are not considered in this analysis

2. Lack of Data, or a Story of Frustration

In our original intention, we were planning to perform three separate pieces of analysis:

1. A static analysis of banks' balance sheet data with a focus on the holdings of instruments most exposed to VR
2. A simplified stress test on banks' holdings of L2 and L3 instruments aimed at determining a first, though high-level, estimate of the potential impact of VR on the CET1 ratio of European banks as a result of a severe but plausible shock to the values of L2 and L3 assets due to valuation uncertainty
3. A review of bank-provided analyses about the sensitivity of the value of L3 instruments to changes in the unobservable inputs used for valuation to understand if and how banks factor that analysis into their prudential capital calculation

We started by defining the methodology for these exercises. To this purpose, we identified the data that we would have ideally required, compared it to the data effectively available from the EBA Transparency Exercise or the individual banks' public disclosures, and determined the gaps. We found that the limitations in data availability were significant and pervasive. We, therefore, defined the assumptions that would have been necessary to fill the gaps and wondered whether such assumptions were reasonable and founded in observed data to a sufficient extent to support reliable conclusions. The data limitations that we encountered are illustrated in Section 2.1.

We decided to perform the static analysis (as summarized in Section 1) by warning that its results should be intended as high-level and tentative and that, in particular, they do not justify any firm conclusions regarding the exposure of any individual bank to VR. On the contrary, we decided not to perform the stress analysis and the sensitivity analysis review. The gap between required and available data was profound and pervasive, and the amount of "heroic assumptions" to be made was too big to allow us to generate trustworthy results, even at a high level.

We reiterate here the important lesson to be learned. Due to insufficient data disclosed by banks, external analysts are not able to infer any reliable conclusions about the risks banks are exposed to as a result of the uncertainty of the valuation of their financial instruments marked at FV. This should be seen as a problem given banks' holding of L2 and L3 instruments in amounts equal to many times their regulatory capital and the potential for significant, negative impacts on banks' capitalization and resilience.

An action by supervisors aimed at substantially overhauling the qualitative and quantitative information disclosed by banks about their holdings of instruments potentially exposed to VR, as well VR mitigation measures adopted, would contribute to improving transparency and risk-awareness in the financial industry.

The following of this Section is organized as follows:

- Paragraph 2.1. contains an illustration of the main data limitations that applied to all our tasks across the board
- Paragraph 2.2 is dedicated to the sensitivity analysis review and includes not only an illustration of the data limitations that specifically affected that task but also a focused discussion of the objectives of this analysis and its informative value in the context of the necessary distinction of VR from other risk types already covered in banks' prudential frameworks (namely, market risk).

2.1. Data Limitations

The following limitations in data availability applied to all our empirical research on VR. They impeached our ability to reach firm, detailed conclusions about the exposure of European banks to VR:

- **Qualitative factors:** a bank's exposure to VR results from a complex set of functional and idiosyncratic elements, not only quantitative but also qualitative, such as the soundness of the governance and control framework around the determination of instrument fair values.[22] In fact, publicly available data is insufficient to enable researchers to discriminate among banks to this effect.
- **VR exposure of L2 instruments:** banks' exposure to VR typically stems from their holdings of financial instruments classified in L2 and L3 of the Fair Value Hierarchy, with L2 instruments representing the bulk of this portfolio. However, L2 instruments

22. Please see Chapter 1 of our whitepaper [1] for a comprehensive discussion of these aspects.

may imply diverse exposures to VR, depending on the "degree of observability" of the inputs used for the valuation (market parameters, model parameters, and models). Based on this consideration, some banks internally adopt sub-categorizations of L2 portfolios by distinguishing between:

  - Instruments "close to L1" that are valued using models with widespread consensus and parameters that can be easily derived from market prices, and
  - Instruments "close to L3" that are valued using less straightforward models and inputs are more likely to be exposed to VR.

  As a result, even banks with similar amounts of L2 instruments can present different exposures to VR. However, banks do not disclose data about the different VR levels of financial instruments classified as L2.[23]

- **Liabilities' contribution to VR:** banks' exposures to VR are the result of their holdings of L2 and L3 assets and liabilities. The contribution of liabilities to a bank's overall VR crucially depends on the correlation of their FV to that of assets - in other words, it depends on whether, and to what extent, the value of liabilities is exposed to the same risk factors as the value of assets, has a similar sensitivity to the same risk factors. The sign of the exposure is the same as that of assets or the opposite. For instance, derivative liabilities aimed at hedging the risk of identified assets are likely to present risk profiles negatively correlated to those of the hedged assets, mitigating the bank's exposure to VR. Other instances of liabilities could, on the contrary, be exposed to different VR factors than assets and therefore directly contribute to a bank's exposure to VR. However, banks do not disclose information that allows inferring significant conclusions about the contribution of L2 and L3 liabilities to VR exposures or their capacity to mitigate the risk.
- **Details on unobservable inputs:** banks disclose too little information about the unobservable inputs they are exposed to, the functional form of the relationship between such inputs and the instrument valuation, and the significance of such inputs for the pricing models used for valuations. Limited information on unobservable inputs is provided as part of banks' narrative on the sensitivity analysis of L3 instrument prices, with no consistency of formats and little detail. No information about the unobservable inputs used for L2 instrument valuation is provided, even though L2 instruments represent the bulk of banks' portfolios exposed to valuation uncertainty.
- **Additional Valuation Adjustments (AVA):** as required by the Capital Requirements Regulation (CRR),[24] banks post AVA in regulatory capital to account for certain elements of uncertainty in the valuation of financial instruments. However, banks generally do not disclose:

  - The amount of AVA posted against the different risk typologies prescribed by the CRR,
  - The methodology for determining AVA,
  - The identification of instruments to which the different AVAs are related (for example, which instrument types they are, whether they are assets or liabilities, in which level of the Fair Value Hierarchy they are classified, etc.), and
  - The interrelation of each AVA component with the corresponding fair value adjustment.[25]

  This prevents analysts from assessing banks' methodology and level of prudence in estimating valuation uncertainty and allocated capital against it.

2.2. Sensitivity Analysis of L3 Instrument Prices to Unobservable Inputs: Specific Data Limitations and Discussion

As prescribed by IFRS13 [4], banks disclose the estimated impact on L3 instrument values of a shock to the unobservable inputs used in the valuation of such instruments. The IFRS13 prescription is purely illustrative; banks are not required to explicitly use the sensitivity analysis results for regulatory capital calculation or any other specified task.

The IFRS13 regulation does not prescribe the disclosure format or the details of the information to be disclosed, so there is no consistency across banks about these elements. Banks generally disclose the main unobservable input(s) that they are using to evaluate each L3 instrument type in their portfolio and estimate the potential impact of a change in these inputs on instruments' value. However, several limitations in data availability prevent researchers from deriving meaningful conclusions about banks' VR exposures from this evidence:

23. Please see Chapter 2 of our whitepaper [1] for a comprehensive discussion of these aspects.
24. Article 34 of CRR [3] requires Institutions to perform a prudent valuation of positions measured at fair value and deduct the resulting AVA from the CET1 capital, while the article 105 of CRR disciplines the AVAs that are intended to achieve an appropriate level of certainty in the prudent value.
25. Please refer to Chapter 2 of our whitepaper [1] for details

- **Harmonization of representation:** the representation of the results disclosed is not uniform across banks. For instance, some banks present the estimated sensitivity in Euro amounts, while others refer to percentages or basis points of price change.
- **Granularity of information:** the level of detail provided varies across banks and does not generally include comprehensive methodological information covering, for instance:
  - The functional shape of the estimated probability distributions of the unobservable inputs,
  - The percentiles considered in the analysis,
  - The functional relationship between the unobservable input(s) and the instrument pricing or other key methodological assumptions.
- **Aggregation rules:** several banks note that their sensitivity analysis does not account for the diversification among the unobservable inputs and the other risk factors considered for L3 instrument pricing. This implies that no reliable estimation of overall L3 portfolio sensitivity to the unobservable inputs can be derived. A simple sum of the maximum estimated price variations in case of adverse scenarios would overestimate the potential losses because it would imply that all the adverse events considered occur simultaneously at a level corresponding to the extreme confidence interval considered.
- **Transparency on mitigation effects:** the level of detail of the information disclosed is not sufficient to determine in a consistent way across banks whether L3 liabilities (including derivatives) should be considered as mitigants for the VR embedded in L3 assets[26] or whether, on the contrary, they contribute to the total VR. Some banks explain in their narratives that the outstanding amounts of instruments considered in the sensitivity analysis are net[27] when this corresponds to the risk management practice followed for such instruments. However, this approach is not consistently adopted across banks, so that a comparison between different situations cannot be reliably executed.

Assuming full data were available, a deep dive into banks' L3 instrument sensitivity analyses could convey a significant amount of information.

One could investigate as a first step whether there is any consistency across banks in the estimated L3 valuation sensitivity with respect to the L3 instruments held.

Possibly more interesting, one could examine the relationship between a bank's estimated L3 price sensitivity and specific risk components considered in its prudential framework for regulatory capital calculation, namely the AVA and non-modellable risk factors:

- **AVA:** banks are required to calculate AVA to account for a set of sources of valuation uncertainty specifically defined by the CRR [3]. From a methodological standpoint, the AVA should represent the variability of a defined adjustment to the instrument fair value defined in the accounting framework.
- **Non-modellable risk factors:** the CRR [3] mandates in the discipline for market risk that when banks hold financial instruments marked at fair value that are exposed to non-modellable risk factors, the regulatory capital for these instruments must be calculated using a more penalizing methodology (Expected Shortfall) compared to that used for other instruments (Value at Risk or VaR).

Such a comparison could shed light on each bank's level of prudence in determining the amount of capital to be allocated against valuation uncertainty.

Additionally, full data disclosure would be instrumental to a key element of analysis into banks' VR. In our previous whitepaper [1], we argued that VR needs to be conceptually and methodologically distinguished from other risks already addressed in banks' prudential frameworks, namely from market risk. In our approach, market risk is determined by measuring the probability that the risk factors relevant for an instrument valuation move against the bank over a defined time horizon (typically 10 days). On the contrary, VR is the possibility that a bank suffers a loss due to a difference between the estimated instrument value and its "exit price" (the price that the bank could obtain from a counterparty by selling an asset or transferring a liability) on the valuation date, that is, with no time interval involved.

26. That is, whether they are exposed to the same unobservable risk factors as the assets with opposite signs.
27. That is, liabilities have been deducted from assets.

In this light, to the extent that a bank's sensitivity analysis considers the potential impact on instrument valuation of input changes over a given time interval, it may be addressing market risk, not necessarily VR. The most appropriate methodology for addressing VR is, in fact, one that allows comparing the bank's valuations with indications of market exit prices — for example, backtesting.

This is, of course, a challenge, as the main source of VR is exactly the fact that only limited information is available about exit prices. We envisage two possible approaches to address this specific aspect, on which additional research would be welcome:

- Whenever sufficient data is available to build a database that includes exit prices for instruments similar to those being evaluated, financial institutions may be able to define benchmark curves that could be used as proxies to assess VR by considering all the adjustments required to account for differences in instrument features as well as in market movements from the moment when the data was collected to the evaluation date.
- Similar to the pricing methodology used for non-performing exposures in industry practice, exit prices could be estimated considering the implied returns that investors are expected to demand for the specific risk taken.[28]

As we stated in our previous whitepaper, supervisors and researchers should advocate for a methodology designed to addresses the definition and measurement of VR widely agreed upon in the industry.

[28] Considering for instance the pricing of a collateralized NPL portfolio, the underlying risk of the collateralized asset class, to be used as a discounting factor of the nominal value, could be calculated as the net annual yield that an investor would obtain considering the annualized expected loss of the portfolio stressing the investment horizon till the weighted average life (duration) of the recovery plan. For example, assuming the expected loss of the non performing portfolio equal to the LGD (usually calculated as the volatility of the initial LGD on the gross book value of the assets) on the net book value (gross book value net of the specific provisions) of the assets, the implied yield would be that LGD plus the weighted average returns on capital the target financial institutions present in their investor communications.

3. Conclusion

With this article, we have attempted to bring a quantitative perspective to the analysis of VR exposures of European banks, which is triggering increasing supervisory attention due to its potential to generate disruptive impacts on the financial system's stability. This follows our first whitepaper on VR, published in November 2020 [1] that addressed VR under a qualitative perspective encompassing methodology, governance, and the interaction between the accounting and prudential regulations.

Our empirical research confirmed the concern, which we had expressed in our first article, that banks' limited disclosure would not enable an external analyst to achieve a good sense of their exposures to VR. We had to dismiss a large part of the analyses that we had initially planned due to the insufficiency of data. Consequently, the conclusions that we could draw are high-level and tentative.

We have discussed in detail the type of information required to infer any firm and reliable conclusions about banks' exposures to VR, the effectiveness of their governance arrangements in measuring and managing this risk, and the extent to which they consider VR in their prudential capital.

The above limitations should be considered as a serious problem. Considering the huge amounts of financial instruments potentially exposed to VR in banks' portfolios, even a relatively small unexpected change to instrument values due to valuation uncertainty could generate significant impacts on banks' capitalization and resiliency.

We are therefore advocating two distinct efforts. We suggest a joint effort by researchers and practitioners to coordinate and develop a methodology for measuring and mitigating valuation risk. We also would welcome an initiative by supervisors and standard-setters to significantly overhaul the amount and depth of the information required by banks around their exposures to VR, having due regard to the uniformity of format to ensure comparability.

As indicated by these articles, Promontory is strongly willing to contribute to this debate and its developments, to improve the banking prudential framework, increase banks' resilience, and enhance the transparency of their risk exposures.

4. References

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