

MACHINE LEARNING IN ACCOUNTING: INSIGHT FROM THE MARCH 2023 BANK FAILURES

Martin Mulyadi *, Yunita Anwar **

* Corresponding author, Shenandoah University, Winchester, Virginia, USA
Contact details: Shenandoah University, 1460 University Drive, VA 22601, Winchester, Virginia, USA
** Shenandoah University, Winchester, Virginia, USA



Abstract

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This research investigates the bank failures in the United States in March 2023, concentrating on the impact of held-to-maturity debt instruments in the event and the implications for accounting methods. Our research deciphers the alleged “accounting loophole” (Farrell, 2023) associated with these securities and provides an in-depth analysis of the associated accounting treatment. We analyze the accounting treatment using the Accounting Standards Codification (ASC) and International Financial Reporting Standards (IFRS). Furthermore, our study employs automated machine learning techniques and the local interpretable model-agnostic explanations (LIME) method to identify key accounting features that could explain bank failures. The research identifies five essential accounting aspects, two of which are related to held-to-maturity assets. The findings underscore the importance of these accounting features in evaluating financial institutions, thereby providing valuable insights for stakeholders, decision-makers, and future research. Our research also advocates for increased transparency and accuracy in accounting practices, via ASC 825 (Financial Accounting Standards Board [FASB], n.d.-a), particularly related to the fair value of held-to-maturity securities.

Keywords: Held-to-Maturity, Bank Failure, Content Analysis, Automated Machine Learning, Financial Statements, Local Interpretable Model-Agnostic Explanations (LIME)

Authors’ individual contribution: Conceptualization — M.M. and Y.A.; Methodology — M.M.; Formal Analysis — M.M. and Y.A.; Writing — M.M. and Y.A.; Project Administration — M.M. and Y.A.

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1. INTRODUCTION

Following the most recent bank failures in the United States in March 2023, this research conducts an investigation from an accounting perspective. These failures, which have been regarded as the second-largest occurrence in terms of total assets since 2001, represent a critical point of scrutiny in contemporary banking and financial research. The total assets involved was \$319,400,000,000, which was only surpassed by the \$373,589,000,000 in total assets recorded during the 2008 global financial crisis, according to the Federal Deposit Insurance Corporation (FDIC, 2023).

Numerous factors, including the inherent risks associated with banks’ lending activities, the complex trade-off between liquidity and profitability, and the factors of market and funding liquidity, have all been implicated in such bank failures in the past (Acharya et al., 2010; Brunnermeier & Pedersen, 2009; Cox & Wang, 2014; Diamond & Dybvig, 1983). However, a more nuanced cause has been suggested for the recent bank failures, notably the accounting treatment of held-to-maturity debt securities. Farrell (2023) refers this to as an “accounting loophole” provoking further examination.

This study takes a comprehensive, two-pronged approach. Our first objective is to deconstruct

the accounting treatment for held-to-maturity debt securities. We want to shed light on the claimed “accounting loophole” that has been frequently discussed in recent publications. To guide our analysis and discussion, we delve into the Accounting Standards Codification (ASC) and International Financial Reporting Standards (IFRS) pertinent to this area. The literature review section provides the required context for us to analyze the accounting methods under question.

Our second objective is to uncover key accounting characteristics that can shed light on the most recent bank failures in the United States. To accomplish this, we use automated machine learning and novel local interpretable model-agnostic explanations (LIME) methodologies. These aid us in sifting through complex accounting datasets and pinpointing the crucial factors at play.

We not only provide a deeper understanding of the accounting approach of the held-to-maturity debt investment through our research, but we also employ automated machine learning and LIME methodologies. In doing so, we make a significant contribution to the growing body of accounting research. Furthermore, our work contributes to the growing debate on the use of advanced machine-learning techniques in accounting research.

The remainder of this paper consists of a literature review in Section 2, followed by our research methodology in Section 3. Section 4 presents and discusses our results, and Section 5 summarizes the key insights and implications of our research.

2. LITERATURE REVIEW

2.1. Generally Accepted Accounting Principles — held-to-maturity debt securities

In the first part of this literature review, we will discuss the Generally Accepted Accounting Principles (GAAP) regarding held-to-maturity securities. The following ASC 320-10-25 (Financial Accounting Standards Board [FASB], n.d.-b), below provides guidance on recognition of the held-to-maturity debt securities.

“At acquisition, an entity shall classify debt securities into one of the following three categories:

a) *Trading securities*. If a security is acquired with the intent of selling it within hours or days, the security shall be classified as trading. However, at acquisition an entity is not precluded from classifying as trading a security it plans to hold for a longer period. Classification of security as trading shall not be precluded simply because the entity does not intend to sell it in the near term.

b) *Available-for-sale securities*. Investments in debt securities not classified as trading securities or as held-to-maturity securities shall be classified as available-for-sale securities.

c) *Held-to-maturity securities*. Investments in debt securities shall be classified as held-to-maturity only if the reporting entity has the positive intent and ability to hold those securities to maturity” (FASB, n.d.-b, ASC 320-10-25-1).

“At acquisition, an investor shall document the classification of debt securities” (FASB, n.d.-b, ASC 320-10-25-2).

“Amortized cost is relevant only if security is actually held to maturity. The use of the held-to-maturity category is restrictive because the use of amortized costs must be justified for each investment in debt security. At acquisition, an entity shall determine if it has the positive intent and ability to hold a security to maturity, which is distinct from the mere absence of an intent to sell. If management’s intention to hold debt security to maturity is uncertain, it is not appropriate to carry that investment at amortized cost. In establishing intent, an entity shall consider pertinent historical experience, such as sales and transfers of debt securities classified as held-to-maturity. A pattern of sales or transfers of those securities is inconsistent with an expressed current intent to hold similar debt securities to maturity” (FASB, n.d.-b, ASC 320-10-25-3).

The FASBs ASC above states that securities will be categorized as held-to-maturity if the reporting organization has the positive intent and ability to hold them until maturity. Additionally, the reporting organization must classify this when the securities are purchased. If held-to-maturity is chosen, this reporting entity will record these securities on their balance sheet at amortized cost rather than fair value.

Additional disclosures are also required, as per the ASC 320-10-50 (FASB, n.d.-b) below.

“All reporting entities shall disclose the following for securities classified as held to maturity by major security type as of each date for which a statement of financial position is presented:

- a) amortized cost basis:
 - aa) subparagraph superseded by Accounting Standards Update No. 2019-04;
 - b) subparagraph superseded by Accounting Standards Update No. 2019-04;
 - c) subparagraph superseded by Accounting Standards Update No. 2019-04;
 - d) net carrying amount:
 - dd) total other-than-temporary impairment recognized in accumulated other comprehensive income;
 - e) gross gains and losses in accumulated other comprehensive income for any derivatives that hedged the forecasted acquisition of the held-to-maturity securities;
 - f) information about the contractual maturities of those securities as of the date of the most recent statement of financial position presented. (Maturity information may be combined in appropriate groupings. In complying with this requirement, financial institutions [see paragraph 942-320-50-1] shall disclose the net carrying amount of debt securities on the basis of at least the following four maturity groupings:
 - 1) within 1 year;
 - 2) after 1 year through 5 years;
 - 3) after 5 years through 10 years;
 - 4) after 10 years.

Securities not due at a single maturity date, such as mortgage-backed securities, may be disclosed separately rather than allocated over several maturity groupings; if allocated, the basis for allocation also shall be disclosed” (FASB, n.d.-b, ASC 320-10-50-5).

“A financial institution that is a public business entity shall disclose the fair value of the debt securities classified as held to maturity, by major

security type, on the basis of at least the following four maturity groupings:

- 1) within 1 year;
- 2) after 1 year through 5 years;
- 3) after 5 years through 10 years;
- 4) after 10 years.

Securities not due at a single maturity date, such as mortgage-backed securities, may be disclosed separately rather than allocated over several maturity groupings; if allocated, the basis for allocation also shall be disclosed” (FASB, n.d.-b, ASC 320-10-50-5B).

As noted in the introduction section, the underlying issues with the 2023 bank failure have been attributed to held-to-maturity securities (Levine, 2023; Sorkin et al., 2023). According to Sorkin et al. (2023), the fact that these held-to-maturity securities are reported at amortized cost rather than fair value gives investors a slightly skewed perception of the balance sheet. And also, “So long as a bank doesn’t need to sell “hold-to-maturity” assets to meet withdrawal requests, there is no problem. But if a bank has to sell at a loss, that’s when things get complicated” (Sorkin et al., 2023, para. 6).

This indicates that the problem lies in the fair value of those held-to-maturity debt securities is less than the book value reported on the balance sheet. The FASB, however, allows reporting organizations to choose to account for most financial assets and liabilities at fair value. The following subsection of the literature review will outline the GAAP regarding the fair value option.

2.2. Generally Accepted Accounting Principles — fair value options

The following ASC 825 (FASB, n.d.-a) guides how the reporting organization can elect the fair value options.

“All entities may elect the fair value option for any of the following eligible items:

- a) a recognized financial asset and financial liability, except any listed in the following paragraph;
- b) a firm commitment that would otherwise not be recognized at inception and that involves only financial instruments (for example, a forward purchase contract for a loan that is not readily convertible to cash — that commitment involves only financial instruments — a loan and cash — and would not otherwise be recognized because it is not a derivative instrument);
- c) a written loan commitment;
- d) the rights and obligations under an insurance contract that has both of the following characteristics:
 - 1) the insurance contract is not a financial instrument (because it requires or permits the insurer to provide goods or services rather than a cash settlement);
 - 2) the insurance contract’s terms permit the insurer to settle by paying a third party to provide those goods or services;
- e) the rights and obligations under a warranty that has both of the following characteristics:
 - 1) the warranty is not a financial instrument (because it requires or permits the warrantor to provide goods or services rather than a cash settlement);

2) the warranty’s terms permit the warrantor to settle by paying a third party to provide those goods or services;

A host financial instrument resulting from the separation of an embedded nonfinancial derivative from a nonfinancial hybrid instrument under paragraph 815-15-25-1, subject to the scope exceptions in the following paragraph (for example, an instrument in which the value of the bifurcated embedded derivative is payable in cash, services, or merchandise but the debt host is payable only in cash)” (FASB, n.d.-a, ASC 825-10-15-4).

“No entity may elect the fair value option for any of the following financial assets and financial liabilities:

- a) an investment in a subsidiary that the entity is required to consolidate;
- b) an interest in a variable interest entity (VIE) that the entity is required to consolidate;
- c) employers’ and plans’ obligations (or assets representing net overfunded positions) for pension benefits, other postretirement benefits (including health care and life insurance benefits), post-employment benefits, employee stock option and stock purchase plans, and other forms of deferred compensation arrangements, as defined in Topics 420, 710, 712, 715, 718, and 960;
- d) financial assets and financial liabilities recognized under leases as defined in subtopics 840-10. (This exception does not apply to a guarantee of a third-party lease obligation or a contingent obligation arising from a cancelled lease);
- e) deposit liabilities, withdrawable on demand, of banks, savings and loan associations, credit unions, and other similar depository institutions;
- f) financial instruments that are, in whole or in part, classified by the issuer as a component of shareholders’ equity (including temporary equity) (for example, a convertible debt instrument within the scope of the Cash Conversion Subsections of Subtopic 470-20 or convertible debt security with a noncontingent beneficial conversion feature)” (FASB, n.d.-a, ASC 825-10-15-5).

2.3. International Financial Reporting Standard 9 — financial instruments

The accounting treatment and reporting requirements following the IFRS will be covered in this subsection. The FASB and the U.S. Securities and Exchange (SEC) have been attempting to converge U.S. GAAP and IFRS, but the IFRS have not yet been accepted in the U.S. Despite evidence indicating IFRS implementation enhances comparability (Barth et al., 2012), there is still a difference between the two standards. This has been attributed to the different standards stakeholders (Hughes et al., 2017), and it may rely on how the SEC chair drives the convergence efforts (Becker et al., 2022).

Unlike the U.S. GAAP, the IFRS doesn’t recognize the term “held-to-maturity” in recording debt investments. The International Accounting Standards Board (IASB) provides the following guidance in regard to debt securities in IFRS 9 (IASB, 2014):

“An entity shall recognise a financial asset or a financial liability in its statement of financial position when, and only when, the entity becomes a party to the contractual provisions of the instrument (see paragraphs B3.1.1 and B3.1.2).

When an entity first recognises a financial asset, it shall classify it in accordance with paragraphs 4.1.1–4.1.5 and measure it in accordance with paragraphs 5.1.1–5.1.3. When an entity first recognises a financial liability, it shall classify it in accordance with paragraphs 4.2.1 and 4.2.2 and measure it in accordance with paragraph 5.1.1” (IFRS, 2014, para. 3.1.1).

“Unless paragraph 4.1.5 applies, an entity shall classify financial assets as subsequently measured at amortised cost, fair value through other comprehensive income or fair value through profit or loss on the basis of both:

a) the entity’s business model for managing the financial assets;
b) the contractual cash flow characteristics of the financial asset” (IFRS, 2014, para. 4.1.1).

“A financial asset shall be measured at amortised cost if both of the following conditions are met:

a) the financial asset is held within a business model whose objective is to hold financial assets in order to collect contractual cash flows;

b) the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

Paragraphs B4.1.1–B4.1.26 provide guidance on how to apply these conditions” (IFRS, 2014, para. 4.1.2).

“A financial asset shall be measured at fair value through other comprehensive income if both of the following conditions are met:

a) the financial asset is held within a business model whose objective is achieved by both collecting contractual cash flows and selling financial assets;

b) the contractual terms of the financial asset give rise on specified dates to cash flows that are solely payments of principal and interest on the principal amount outstanding.

Paragraphs B4.1.1–B4.1.26 provide guidance on how to apply these conditions” (IFRS, 2014, para. 4.1.2A).

“For the purpose of applying paragraphs 4.1.2(b) and 4.1.2A(b):

a) a principal is the fair value of the financial asset at initial recognition; paragraph B4.1.7B provides additional guidance on the meaning of principal;

b) interest consists of consideration for the time value of money, for the credit risk associated with the principal amount outstanding during a particular period of time and for other basic lending risks and costs, as well as a profit margin; paragraphs B4.1.7A and B4.1.9A–B4.1.9E provide additional guidance on the meaning of interest, including the meaning of the time value of money” (IFRS, 2014, para. 4.1.3).

“A financial asset shall be measured at fair value through profit or loss unless it is measured at amortised cost in accordance with paragraph 4.1.2 or at fair value through other comprehensive income in accordance with paragraph 4.1.2A. However, an entity may make an irrevocable election at initial recognition for particular investments in equity instruments that would otherwise be measured at fair value through profit or loss to present subsequent changes in fair value in other comprehensive income (see paragraphs 5.7.5–5.7.6)” (IFRS, 2014, para. 4.1.4).

“Despite paragraphs 4.1.1–4.1.4, an entity may, at initial recognition, irrevocably designate a financial asset as measured at fair value through profit or loss if doing so eliminates or significantly reduces a measurement or recognition inconsistency (sometimes referred to as an “accounting mismatch”) that would otherwise arise from measuring assets or liabilities or recognising the gains and losses on them on different bases (see paragraphs B4.1.29–B4.1.32)” (IFRS, 2014, para. 4.1.5).

“After initial recognition, an entity shall measure a financial asset in accordance with paragraphs 4.1.1–4.1.5 at:

a) amortised cost;
b) fair value through other comprehensive income;

c) fair value through profit or loss” (IFRS, 2014, para. 5.2.1).

Even though the IFRS does not recognize the term “held-to-maturity”, the accounting approach would not be different under IFRS 9. Per the GAAP, if a reporting organization has the capability and affirmative purpose to retain certain debt instruments until maturity, this will be recorded as “held-to-maturity” and shown on the balance sheet at its amortized cost. Per IFRS 9, a reporting organization’s financial assets will also be reported at their amortized cost if its goal is to hold them in order to generate cash flows.

The following section outlines the research methodologies of this paper that we used to answer our two research objectives.

3. RESEARCH METHODOLOGY

In order to explain the accounting treatment and reporting requirements of the held-to-maturity debt securities, we perform a content analysis of the failing bank’s annual report (form 10-K) in the first section of our study to explore this issue. Prior research suggests that the financial institution’s financial statements might explain this condition (Blum & Raviv, 2023). Through the financial institution’s website, we obtained their most recent annual report, which was submitted on February 24, 2023 (SVB Financial Group [SVBFG], 2023). Using the accounting rules outlined in Section 2 as a benchmark, we perform the exploratory analysis via content analysis of this annual report to explain how the failing bank reported and accounted for its held-to-maturity debt instruments.

We also used automated machine learning to explain further the top accounting features that can explain the most recent bank failures in the United States. Combining various research approaches to examine a situation has been common practice, for example, the study by Mion et al. (2023). In their study, Nazareth and Reddy (2023) describe how current developments in machine learning have been used in banking and finance, including in bankruptcy and insolvency. A recent paper by Lu et al. (2022), Morrone et al. (2022), and van der Heijden (2022) explain how the machine learning approach can be utilized in accounting, auditing, and corporate governance research. Our study uses the H2O automated machine learning framework to address our second research objective. The H2O automated machine learning study by Schmitt (2023) demonstrates the potential capability

of H2O. His paper also referred to earlier studies that compared various automated machine-learning frameworks.

While a standard regression analysis would provide alternative methodologies using this dataset, this may not capture complex non-linear relationships between variables present in financial data (Hastie et al., 2009; James et al., 2013). By using H2O automated machine learning, we allow the identification of these complex non-linear relationships, thereby enhancing the explanatory power of our analysis. Additionally, the H2O automated machine learning framework has been demonstrated to outperform other machine learning frameworks in terms of predictive accuracy (Gijsbers et al., 2019; Truong et al., 2019), suggesting that our approach can provide more accurate and reliable results in identifying the key accounting features associated with bank failures.

We analyzed financial statements information, performance and condition ratios obtained from the FDIC publicly available bank data to conduct the exploratory analysis to explain the most recent bank failures. We utilize the area under the curve (AUC), a measure that is frequently used in business research, such as those by Afriyie et al. (2023), Carmona et al. (2022) and Li et al. (2023), to measure the model performance as the outcomes of H2O automated machine learning. We select the model

with the highest AUC, where a value of one represents the best fit to the data. Furthermore, to interpret the results of the highest-performing model, we utilize the novel LIME method. This method allows us to extract the top key accounting features related to the most recent bank failure in the United States. Such an approach has been used in the most recent research to explain the results of automated machine learning (Ahsan et al., 2023; Bas et al., 2023; Nematzadeh et al., 2023; Çelik et al., 2023).

4. RESULTS AND DISCUSSION

4.1. Held-to-maturity debt securities accounting treatment and disclosures analysis

The failed bank's accounting treatment of its held-to-maturity debt instruments and how they record and disclose information about this asset are the subject of our analysis in this subsection. Since held-to-maturity debt securities have been identified as the primary problems with the most recent collapsed bank in the United States, we concentrate on these assets (Farrell, 2023; Levine, 2023; Sorkin et al., 2023). We obtained the most recent annual report (form 10-K) (SVBFG, 2023) of the failed bank from their website and provide their partial consolidated balance sheets below.

Table 1. Partial consolidated balance sheets

Assets	December 31	
	2022	2021
Cash and cash equivalents	\$13,803	\$14,586
Available-for-sale securities, at fair value (cost of \$28,602 and \$27,370, respectively, including \$530 and \$61 pledged as collateral, respectively)	26,069	27,221
Held-to-maturity securities, at amortized cost and net of allowance for credit losses of \$6 and \$7 (fair value of \$76,169 and \$97,227, respectively)	91,321	98,195
Non-marketable and other equity securities	2,664	2,543
Total investment securities	120,054	127,959
Loans, amortized cost	74,250	66,276
Allowance for credit losses: loans	(636)	(422)
Net loans	73,614	65,854
Premises and equipment, net of accumulated depreciation and amortization	394	270
Goodwill	375	375
Other intangible assets, net	136	160
Lease right-of-use assets	335	313
Accrued interest receivable and other assets	3,082	1,791
Total assets	\$211,793	\$211,308

Note: Dollars in millions, except par value and share data.
Source: SVBFG (2023).

As can be seen from the partial consolidated balance sheets in Table 1, there are two securities reported by the failed bank namely: available-for-sale securities and held-to-maturity securities. The available-for-sale securities are reported at their fair values, and the held-to-maturity securities are reported at their amortized costs. These accounting treatments are following ASC 320-10-25 (FASB, n.d.-b). However, it is also important to note, that the fair values of these held-to-maturity securities are disclosed on the body of the consolidated balance sheets. Further information regarding these held-to-maturity securities is provided in the Notes to the Consolidated Financial Statements (SVBFG, 2023), and we provided the disclosures on the held-to-maturity securities on December 31, 2022, in Tables 2 and 3.

While the amortized cost of the held-to-maturity securities the organization had on December 31, 2022, and December 31, 2021, is disclosed in the consolidated balance sheets together with their fair values, further information is provided in the Notes to the Consolidated Financial Statements (SVBFG, 2023). Table 2 depicts the complete information regarding the portfolio's held-to-maturity components (amortized cost, unrealized profits and losses, and fair value). Moreover, according to ASC 320-10-50-5B (FASB, n.d.-b), additional information is also supplied, as shown in Table 3, about the disclosures of held-to-maturity securities based on at least four maturity categories. These tables detail the held-to-maturity securities' \$91,321 million amortized cost and their \$76,169 million fair value as of December 31, 2022.

Table 2. Partial Notes to the Consolidated Financial Statements (Part 1)

	December 31, 2022					
	Amortized cost	Unrealized gains	Unrealized losses	Fair value	ACL ²	Net carry value
<i>HTM securities, at a cost:</i>						
U.S. agency debentures ¹	\$486	-	(\$52)	\$434		\$486
<i>Residential MBS:</i>						
Agency-issued MBS	57,705	-	(9,349)	48,356	-	57,705
Agency-issued CMO-fixed rate	10,461	-	(1,885)	8,576	-	10,461
Agency-issued CMO-variable rate	79	-	(2)	77	-	79
Agency-issued CMBS	14,471	-	(2,494)	11,977	-	14,471
Municipal bonds and notes	7,417	2	(1,269)	6,150	1	7,416
Corporate bonds	708	-	(109)	599	5	703
Total HTM securities	\$91,327	\$2	(\$15,160)	\$76,169	\$6	\$91,321

Note: Dollars in millions, except par value and share data. MBS — Mortgage-backed securities, CMO — Collateralized mortgage obligations, CMBS — Commercial mortgage-backed securities, HTM — Held-to-maturity.

¹ Consists of pools of Small Business Investment Company debentures issued and guaranteed by the Small Business Administration (SBA), an independent agency of the United States; ² refers to the summary of significant accounting policies (allowance for credit losses [ACL]) for more information on our credit loss methodology.

Source: SVBFG (2023).

Table 3. Partial Notes to the Consolidated Financial Statements (Part 2)

	December 31, 2022									
	Total		1 year or less		After 1 year to 5 years		After 5 years to 10 years		After 10 years	
	Net carry value	Fair value	Net carry value	Fair value	Net carry value	Fair value	Net carry value	Fair value	Net carry value	Fair value
U.S. agency debentures	\$486	\$434	\$1	\$1	\$118	\$111	\$367	\$322	-	-
<i>Residential MBS:</i>										
Agency-issued MBS	57,705	48,356	-	-	25	24	1,066	994	56,614	47,338
Agency-issued CMO-fixed rate	10,461	8,576	-	-	90	86	129	120	10,242	8,370
Agency-issued CMO-variable rate	79	77	-	-	-	-	-	-	79	77
Agency-issued CMBS	14,471	11,977	39	38	153	141	966	810	13,313	10,988
Municipal bonds and notes	7,416	6,150	29	29	235	224	1,362	1,244	5,790	4,653
Corporate bonds	703	599	-	-	115	103	588	496	-	-
Total	\$91,321	\$76,169	\$69	\$68	\$736	\$689	\$4,478	\$3,986	\$86,038	\$71,426

Note: Dollars in millions, except par value and share data. MBS — Mortgage-backed securities, CMO — Collateralized mortgage obligations, CMBS — Commercial mortgage-backed securities.

Source: SVBFG (2023).

Our analysis of the failed bank's annual report (form 10-K) reveals that its held-to-maturity debt securities' accounting treatment and disclosures comply with U.S. GAAP. In reporting their held-to-maturity debt securities, they followed the ASC and used the amortized cost rather than the fair value. Some may refer to this as an "accounting loophole", but in reality, they included more information about the fair value of these securities directly in the body of the consolidated balance sheets. This informs the stakeholders and shows that it is clear that unrealized losses exist when comparing the asset's amortized cost and fair value.

But, if the bank chooses the fair value option under ASC 825, such inconsistencies shouldn't exist. In the consolidated balance sheets, the held-to-maturity would have been reported at its fair value rather than its amortized cost under this fair value option. The U.S. GAAP and the IFRS also needed to be compared in this circumstance. We listed the pertinent IFRS 9 accounting standard in Section 2. Although the IFRS does not recognize the term "held-to-maturity", the accounting treatment is not different. Depending on the circumstances outlined in paragraph 4.1.2, a financial asset may be valued at amortized cost or fair value under IFRS 9. The primary distinction is whether the organization's business model can be realized through the collection of contractual cash flows alone or the simultaneous sale of financial assets and collecting contractual cash flows.

Accounting regulations play an essential role in valuation that goes beyond regulatory compliance. These regulations serve as guidelines, allowing stakeholders to forecast future cash flows and assess the financial institution's financial health. While the amortized cost provides a mechanism for projecting future cash inflows from these assets, assessing the fair value of these securities is critical, especially during market volatility. Fair value options under ASC 825 can provide a different, market-driven perspective on the value of the assets and prospective future cash flow. A valuation approach that presents both amortized cost and fair value transparently can provide stakeholders with a more complete picture of the bank's financial position and potential future performance. Although optional, the failing bank's practice of disclosing both amortized cost and fair value is consistent with this approach, providing stakeholders with a more comprehensive set of facts for future cash flow evaluation.

4.2. Top key accounting features related to the most recent bank failure in the U.S.

By describing the failed bank's accounting treatment of held-to-maturity debt securities and addressing the alleged "accounting loophole", subsection 4.1 answers our first research objective. We also expressed that a suitable way to prevent these discrepancies would be to use the fair value option

under ASC 825. We extend our analysis by using H2O automated machine learning and the LIME method to address our second research objective. The top key accounting features associated with the most recent bank failure in the United States are listed in this subsection.

We investigated the accounting factors associated with the most recent bank failure in the United States using 5 k-fold cross validation and a maximum runtime of 30 seconds. Two of the 45 models that emerged from our final models have an AUC of more than 0.9. With various model performance measuring metrics, we listed the top five models in Table 4.

Table 4. H2O automated machine learning models

Model	AUC	logloss	AUCPR	RMSE	MSE
1	0.9242	0.1506	0.2888	0.2122	0.0451
2	0.9090	0.3428	0.2299	0.2683	0.0720
3	0.8939	0.4172	0.2528	0.2386	0.0569
4	0.8788	0.3205	0.1891	0.2601	0.0677
5	0.8636	0.1626	0.2320	0.2184	0.0477

Note: AUC — Area under the curve, AUCPR — Area under the precision-recall curve, RMSE — Root mean square error, MSE — Mean squared error.
Source: Authors' analysis.

We chose Model 1 for further study utilizing the LIME method, using the AUC as our primary indicator and considering four other model performance measures. We concluded that Model 1 is the best model for our further analysis, according to Mandrekar (2010), who stated that an AUC of higher than 0.9 is regarded as outstanding and supported by four other measures.

We used 4,000 permutations and eight kernel widths in our LIME method analysis to describe the outcomes of Model 1 of our H2O automated machine learning. According to our model, these are the top five key accounting features that may explain the bank's failure:

- 1) ERNASTR (earning assets to total assets) — interest-earning assets as a percent of total assets;
- 2) NONIAY (noninterest income to average assets) — income derived from bank services and sources other than interest-bearing assets (annualized) as a percent of average total assets;
- 3) NONIXAY (noninterest expense to average assets) — salaries and employees benefits, expenses of premises and fixed assets, and other noninterest expenses (annualized) as a percent of average total assets;
- 4) EQV (equity capital to assets) — the estimated amount of uninsured deposits in domestic offices and insured branches in Puerto Rico and U.S. territories and possessions reported by the institution;
- 5) INTINCY (yield on earning assets) — total interest income (annualized) as a percent of average earning assets.

The first accounting element that can shed light on the bank's failure is the held-to-maturity debt securities, which are included in the ERNASTR condition ratio and INTINCY performance ratio. The two accounting aspects that follow have to do with noninterest income and expense to average assets. Estimated uninsured deposit amounts also contribute to the explanation of the bank's failure. We tested our model on a second U.S. bank that failed in March 2023 using the LIME method in order to validate it. These four features are also confirmed

as the most critical accounting features that may help to explain the failure of the second bank in March 2023, according to the LIME method.

Our H2O automated machine learning analysis provides evidence that the 2023 failure of a U.S. bank is closely related to its held-to-maturity securities. By leveraging advanced algorithms that identify complex non-linear relationships between variables, our study offers a deeper understanding of the factors influencing this bank failure.

Our analysis suggests that adopting the fair value alternative under ASC 825, which utilizes fair value for held-to-maturity securities instead of the amortized cost currently employed by the failing bank, would provide a more accurate and transparent representation of the financial institution's true economic position. This finding supports the recommendation presented in subsection 4.1, highlighting the potential benefits of adopting fair value accounting for these securities.

Moreover, our H2O automated machine learning results shed light on the accounting elements that stakeholders should be particularly attentive to when evaluating a financial institution's performance. Specifically, the analysis identifies uninsured deposits as a critical risk factor, emphasizing the importance of monitoring this aspect of a bank's financial health.

Additionally, our findings underscore the relevance of certain performance ratios, such as the noninterest revenue to average assets, the noninterest expense to average assets, and interest-earning assets (including held-to-maturity securities). These ratios serve as key indicators of a financial institution's overall performance and stability and should be carefully considered by stakeholders in their decision-making process.

Our study offers valuable insights into the accounting features associated with recent bank failures, enabling stakeholders to make more informed decisions when evaluating the performance of financial institutions. Furthermore, our findings contribute to the ongoing debate on the appropriate accounting treatment for held-to-maturity securities, supporting the argument for adopting fair value accounting to enhance transparency and accuracy in financial reporting.

5. CONCLUSION

This research examines the most recent bank failures that occurred in the United States in March 2023, the second-largest since 2001. This research was driven by existing publications implicating the accounting treatment of the held-to-maturity debt securities in these failures (Farrell, 2023; Levine, 2023; Sorkin et al., 2023), with Farrell (2023) calling it an "accounting loophole". We aimed to explain the nature of held-to-maturity debt securities accounting and reporting by reviewing the ASC of the United States GAAP and the IFRS, thus disputing this "loophole" assertion.

We investigated the data further using the H2O automated machine learning platform and the local interpretable model-agnostic explanations technique. The best model yielded an AUC of 0.92 and identified five essential accounting elements as influential in bank failures: held-to-maturity assets, uninsured deposits, noninterest revenue, and noninterest expense.

For stakeholders and decision-makers, these findings underscore the crucial role of accounting features in evaluating the performance and risks associated with financial institutions. In particular, a more nuanced understanding of held-to-maturity securities' impact on bank stability can lead to more effective oversight and risk management strategies. Furthermore, adopting the fair value option under GAAP's ASC 825 could promote greater transparency and accuracy in depicting the fair value of these securities, enhancing stakeholders' capacity to make informed decisions.

From a managerial perspective, our study advocates for a keen focus on the identified top five accounting features when evaluating the performance of a financial institution. It emphasizes the need to have a thorough awareness of these essential qualities, which can serve as an early warning system for future bank problems. Moreover, it calls for a proactive approach to implementing robust internal control measures to manage these identified risks effectively.

Despite the insights gained, this study has limitations. The dataset used primarily centered on

the banks that failed in March 2023 and may not reflect other banking institutions or periods. Thus, the findings should be generalized with caution. Furthermore, while the automated machine learning model demonstrated high performance, the usage of different data analytics tools might yield different findings, indicating that machine learning outputs should always be cross-verified for robustness.

This study not only adds to the discussion of the accounting treatment of held-to-maturity securities but it also offers up new paths for future research. It illustrates the effectiveness of automated machine learning and the local interpretable model-agnostic explanations method in comprehending complicated accounting datasets, hence encouraging its use in future accounting research. Furthermore, our study provides a foundational framework for understanding the critical accounting features contributing to recent bank failures in the United States. Future research could build on this framework, extending the analysis of these accounting features across a broader range of financial institutions in the U.S. or other countries over an extended period.

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