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# EUROPEAN MUTUAL BANKS AT A CROSSROADS: FACING CLIMATE CHALLENGES AND TRADITIONAL BANKS

Sarah Goldman<sup>1</sup>, Maya JANDAH<sup>2</sup>

*Abstract: Mutual banks hold a unique position in the European financial landscape, rooted in principles of solidarity and democratic governance. Despite their strong local ties and social mission, they face significant challenges in sustainability, particularly in transitioning to a low-carbon economy. This paper traces the historical evolution of mutual banking, analyzes the reasons behind their lag in decarbonization compared to traditional banks, and offers concrete recommendations to strengthen their climate engagement. The study highlights the sector's diverse climate performance through comparative analysis and the use of data science tools, emphasizing the need for targeted institutional reforms to accelerate the ecological transition.*

*Keywords: Mutual banks, sustainability, governance, and climate.*

*JEL: P13, Q56, G30, G39, Q50, Q59*

*Editorial Note :*

*This manuscript has been linguistically refined using DeepL, Grammarly, and Quillbot to enhance clarity, coherence, and multilingual accuracy.*

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## **1- Introduction**

Emerging in the 19th century amid widespread social and economic hardship, mutual banks were conceived as instruments of solidarity and financial inclusion. Their participatory governance model—where customers are also members—embodies an alternative vision of finance centered on collective benefit. As Guider and Roux (2009) observed, mutual banks have evolved from modest local initiatives into influential financial institutions. Nevertheless, despite decades of hybridization with conventional banking practices (Apothéloz, 2024, Interview of Olivier Pastré, Professor of Economics at the University of Paris VIII), their structure remains distinct, preserving a cooperative ethos that sets them apart.

Today, mutual banks face mounting pressure to redefine their strategic role in response to contemporary challenges, including climate change, digital transformation, and intensifying market competition. Their climate commitments, in particular, remain uneven and often lag behind those of commercial banks. This paper examines the historical foundations, structural characteristics, and limitations of the mutual banking model, with a focus on its capacity to support decarbonization and contribute to sustainable finance.

The first part of the analysis explores how the historical trajectory of mutual banks continues to shape their identity and operational logic (Section 1). The second part examines how European mutual banks navigate the dual pressures of climate responsibility and competitive dynamics in the 21st century (Section 2). The conclusion reflects on the strategic adjustments needed to ensure mutual banks remain relevant and impactful in a rapidly evolving financial landscape.

## **2. Mutual Banks: A History Shaping the Future**

The roots of mutual banks date back to the 19th century, a period of economic and social upheaval in Europe (Moulevrier, 2002; Institut Montaigne, 2014; Migliorelli, 2018). The industrial revolution led to a massive migration of rural populations to urban centers, where living conditions were often precarious. In this context, visionary founders like Friedrich Wilhelm Raiffeisen in Germany created financial institutions based on principles of solidarity and cooperation. In 1864, Raiffeisen founded the first cooperative bank to help local farmers escape usury and poverty.

Raiffeisen's model quickly found echoes in other European countries. In France, the *Crédit Agricole* bank was founded in 1885 to support French farmers, while the *Caisse d'Epargne*

was created in 1818 to encourage savings among the working classes. In Italy, cooperative banks emerged in the 1880s, supporting small businesses and artisans. In Belgium, the People's Banks emerged in the 1860s, promoting access to credit for workers.

The 20th century is akin to a period of consolidation and diversification for mutual banks. These banks expanded their services after the First World War, including mortgages, insurance, and savings products. During the Great Depression of the 1930s, mutual banks often served as a lifeline for small businesses and households. After World War II, they played a crucial role in Europe's economic reconstruction by financing infrastructure projects and supporting industrialization (European Economic and Social Committee, 2018).

The following decades saw mutual banks face numerous challenges. The deregulation of financial markets in the 1980s and 1990s introduced increased competition from commercial banks (Jeffers & Pollin, 2012). To remain competitive, many mutual banks adopted structural reforms, merged with other institutions, and diversified their activities. Moreover, they had to adapt to the new banking regulations imposed by the European Union and national authorities (Lobre & Cartier, 2012).

Today, mutual banks represent a significant portion of the European banking sector. In 2025, several thousand mutual banks in Europe will be grouped into national and regional networks (Association of European Cooperative Banks (EACB), 2025)<sup>3</sup>.

The EACB brings together 2,400 cooperative banks, serving 227 million customers and having 90 million members. Mutual banks continue to evolve to meet the needs of a rapidly changing financial environment (financial crises, health crises, and international conflicts) and emphasize digital innovation, offering online banking services and mobile applications to attract a younger clientele. On the other hand, they timidly engage in social and environmental responsibility initiatives by financing sustainable projects and supporting local communities, as sustainability is in their DNA (Kosinowski, 2020).

In summary, the history of mutual organizations in Europe illustrates their remarkable capacity for resilience and adaptability. Born out of the needs of local communities, they have managed to transform themselves into pillars of the banking sector, while striving to preserve their values of solidarity and cooperation in a context of hybridization<sup>4</sup>. These qualities are

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<sup>3</sup> <https://www.eacb.coop/en/home.html>

<sup>4</sup>It is a transition towards a mixed or combined model, where these banks integrate modern or commercial practices without denying their solidarity ownership.

significant assets within the European sustainable financial landscape (Bevilacqua, 2022). Whether they can fully mobilize them to regain their place in the sustainability dynamic remains to be seen.

Before addressing the shortcomings of cooperative banks compared to traditional banks in greening the economy, it is helpful to clarify two points beforehand. Firstly, mutual banks are distinguished by several fundamental principles that guide their operation and mission. Secondly, this study focuses on banks aiming for decarbonization by joining the Net-Zero Banking Alliance (NZBA). Launched in 2020, this innovation brings together globally significant banks to achieve net-zero emissions by 2050.

Mutual banks and their classical counterparts play essential roles in the European financial landscape, but they differ in structure, governance, and mission. Mutual banks are owned by their members, who are also their customers. Each member owns social shares and has a right to vote, often based on the principle "one person, one vote." This democratic structure ensures that decisions are made in the best interest of all members. On the other hand, private banks are generally owned by shareholders. Their governance is geared toward maximizing profits and return on investment for shareholders, which can sometimes conflict with the interests of customers<sup>5</sup>.

Cooperative structures aim to serve their members and promote local economic and social development. They emphasize solidarity, mutual aid, and local roots, supporting community projects and offering financial services on advantageous terms. Conventional banks, on the other hand, primarily focus on profitability and the expansion of their activities. They tend to operate on a larger scale and offer a broader range of financial services. Let us note that mutual banks often adopt a prudent management approach and avoid risky speculative activities. Their main objective is to maintain financial stability and reinvest profits in the institution or in projects of general interest. On the other hand, Standard banks can take higher risks to maximize profits and often engage in complex and speculative market activities<sup>6</sup>.

Regarding sustainability, standard banks often have more resources and influence to invest in environmental and social initiatives. However, although sometimes lagging in this area, mutual banks are firmly committed to responsible and sustainable practices that align with their values of solidarity and local development.

### **3. Carbon transition: Deciphering the gaps and roadmap**

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<sup>5</sup> Banques coopératives et mutualistes : différences et avantages

<sup>6</sup> Banques coopératives contre banques traditionnelles : deux modèles, deux visions de la finance

Mutual banks in Europe face specific challenges in decarbonization, which differ from those traditional banks face. To understand this delay, it is essential to examine the current situation and causes and propose recommendations to bridge this gap.

The assessment of the delay in terms of decarbonization is based on a study conducted by Reclaim Finance in December 2024, which reveals the inadequacies of the current decarbonization targets set by banks worldwide. The analysis focuses exclusively on European mutual and conventional institutions.

Our sample comprises 5 European countries (Germany, Spain, France, Italy, and the Netherlands) and 14 banks, including five mutual banks. The table below presents the primary data regarding CO2 emission reductions, as announced by the banks.

**Table 1. Decarbonization targets of banks in Europe**

Country	Banks	CO2 reduction targets (on average)	Years of zero-carbon targets
Germany	Deutsche Bank	41%	2030
	DZ Bank (BM)	43%	2025 <sup>o</sup> -2050
Spain	BBVA	46%	2030
	Santander	44%	2030
France	BNP Paribas	40%	2025* -2030
	BPCE/Natixis (BM)	45%	2030
	Crédit Agricole (BM)	50%	2025*-2040
	Crédit Mutuel (BM)	15%	2027**-2030
	Banque Postale	38%	2025*-2030
	Société Générale	55%	2025***-2030
Italy	Intesa Sanpaolo	35%	2030
	Unicredit	35%	2030
Netherlands	ING	66%	2030-2050
	Rabobank (BM)	32%	2030

Note: It is essential to emphasize that the results must be interpreted with caution due to the lack of thorough verification of the quality of the reports provided by the banks. Indeed, errors can occur during the information collection processes, despite efforts to ensure rigorous quality control. Moreover, the surveyed banks did not provide all the necessary data, which led to calculations based on their statements, potentially affecting the accuracy of these calculations due to the gaps in the data. BM=Banque Mutualiste. <sup>o</sup> Estimates established in 2022. \* Estimates established in 2020. \*\* Estimates established in 2023. \*\*\*Estimates established in 2019.

All the banks included in this panel have expressed their commitment to reducing CO2 emissions, aiming to achieve carbon neutrality by 2030 or, in some cases, 2050. However, decarbonization targets vary by country and institution. For example, Italy lags behind other nations, with an emissions reduction target set at 35% compared to the reference year. In

Germany, the average emission reduction is expected to reach approximately 42%, with a projected carbon neutrality by 2050. These data illustrate the country's challenges in moving away from fossil fuels, which remain crucial to supporting its economic growth. Conversely, the Netherlands is more ambitious in its fight against CO<sub>2</sub> emissions, with a target to reduce emissions by 49%.

Banking entities show a significant disparity in their CO<sub>2</sub> emission reduction targets. For example, ING plans a 66% reduction, while Société Générale plans a 50% reduction, and Crédit Mutuel has a significantly more modest goal, limited to 15%. On average, traditional banking structures in France and the Netherlands show a more pronounced ambition to achieve carbon neutrality. French institutions aim for an average reduction of 44.3% in their emissions, compared to 36.6% for collective banks. In the Netherlands, the difference is even more notable: mutual banks plan a reduction of 32%, compared to 66% for their conventional counterparts.

To validate the work of NGOs on this topic, we use a data science algorithm that is assumed to provide a clear picture of the position of European banks in the struggle against CO<sub>2</sub> emissions.

Actually, several NGOs, notably Reclaim Finance, as previously mentioned, have raised the question of whether mutualist banks are lagging in CO<sub>2</sub> emissions policy, and this issue should be addressed using data science tools. Their criticism targets the climate commitments and transparency of these institutions, suggesting that mutualist banks often fail to match the ambition and clarity demonstrated by their commercial counterparts. To assess the validity of this claim, we can examine both the qualitative assessments provided by NGOs and the quantitative positioning of banks within a t-SNE framework, which provides a visual representation of climate performance based on abstracted features.

The description of this algorithm helps prepare to discuss the empirical results. t-SNE, or t-distributed Stochastic Neighbor Embedding, is a machine learning algorithm that reduces complex, high-dimensional data into two or three dimensions for visualization. In this context, the two dimensions—T1 and T2—represent latent variables derived from banks' climate-related metrics (scopes 1, 2, and 3), such as emissions disclosures and ESG<sup>7</sup>. The sample considers 17 European banks, at least seven mutual banks, for the 2024 period. Mutual banks account for approximately 41% of our sample, which aligns well with the broader European proportion of mutual banks.

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<sup>7</sup> For more details see Appendices.

Applying these criteria to the dataset reveals a nuanced picture. Among the worst-performing banks, we find Groupe BPCE and Cassa Centrale Banca—both mutualist institutions—alongside commercial banks such as BNP Paribas and Société Générale. These mutualist banks are criticized for limited ESG reporting and weak climate engagement, aligning with Reclaim’s and other NGOs’ concerns. However, the analysis also shows that several mutualist banks occupy the best-performing category. La Banque Postale, Crédit Agricole, Crédit Mutuel, and Groupe ICCREA demonstrate strong climate credentials, with positive T1 and T2 scores, as well as NGO recognition for their Scope 3 transparency and green finance initiatives.

This divergence suggests that while grounded in specific examples, Reclaim Finance’s assertion cannot be generalized across the entire mutualist banking sector. The presence of mutualist banks in both the lowest and highest tiers of climate performance indicates that the industry is heterogeneous. Some institutions lag, but others clearly lead in climate policy and emissions transparency.

In conclusion, the data partially support the claim that mutualist banks are systematically behind in CO<sub>2</sub> emissions policy. While certain mutualist banks exhibit weak climate engagement, others demonstrate exemplary performance. Therefore, it would be more accurate to say that mutualist banks display a wide range of climate strategies, and any critique should be directed at specific institutions rather than the sector as a whole.

It is worth noting that the Reclaim Finance report is a valuable tool for analyzing banks’ behavior in decarbonization. Nevertheless, it is essential to acknowledge certain limitations that extend beyond the mere lack of transparency in calculating metrics and selecting definitions. Indeed, several key data points are missing, and the absence of a time series for 2020-2024 prevents the tracking of the evolution of various metrics, thereby hindering the reliable assessment of efforts towards the carbon transition. Moreover, the databases are organized according to a sectoral and sub-sectoral classification, while recent work questions the relevance of the NACE classification (Statistical Nomenclature of Economic Activities in the European Community). This nomenclature, developed by the European Union, facilitates the comparison of economic statistics between member states; however, its suitability for addressing current challenges is increasingly being discussed. A classification of products by activity (CPA) would facilitate a better understanding of issues related to measuring CO<sub>2</sub> emissions. The most recent version, CPA 2.2, adopted in 2024<sup>8</sup>, includes new categories representing emerging forms of economic activities, particularly those focused on sustainability. However, this approach is still in its early stages of development.

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<sup>8</sup> <https://ec.europa.eu/eurostat/en/web/products-eurostat-news/w/wdn-20241220-1>

The delay of cooperative financial entities in sustainability seems to stem from their complex organizational structure and low inclination to enter a competitive dynamic (Daussy & Coursier, 2023).

Indeed, this complexity, although a reflection of their democratic governance, often leads to a certain slowness in decision-making and the implementation of new initiatives. The multiple levels of governance, from local coffers to national bodies, make smooth and rapid coordination difficult, which can hinder progress in sustainability. Due to this complexity, increasingly demanding regulatory constraints are added. Mutual banks must comply with standards such as IFRS 9<sup>9</sup> and DSP2<sup>10</sup>, which pose additional challenges and require rapid and costly adaptations. They are often difficult to achieve due to their structure and limited resources.

With the rise of Open Banking<sup>11</sup> and the arrival of new digital players, mutual banks compete directly with more agile and technologically advanced institutions. This competition highlights the limitations of the traditional economic models of mutual organizations, which must now reinvent themselves to remain competitive. Moreover, dependence on public aid, although often necessary to ensure their financial stability, can hinder their ability to invest in sustainability initiatives proactively, thereby putting them at a disadvantage compared to traditional banks.

Despite these challenges, mutual banks possess undeniable assets. They have demonstrated remarkable resilience in financial crises, thanks to generally more robust capitalization and lower vulnerability to extreme financial risks. Their local roots and values of proximity and solidarity attract many clients who are drawn to human-scale and socially responsible institutions. However, to ensure sustainability, these banks must adapt their governance to better manage their organizational complexity<sup>12</sup>.

To catch up in sustainability, particularly in decarbonization, mutual banks could consider several areas for improvement. Diversifying their activities is a priority to reduce their dependence on public aid and increase their resilience. European states, facing increasing debt, may eventually consider reducing or ending their financial support to cooperative banks. Exploring mergers and acquisitions could enhance competitiveness by creating synergies and

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<sup>9</sup> The international accounting standard IFRS 9 (International Financial Reporting Standard 9) governs financial instruments. It establishes the principles related to their classification, measurement, and impairment. Introduced with the aim of enhancing the transparency and reliability of financial data, this standard was designed in response to the shortcomings highlighted by the 2008 crisis.

<sup>10</sup> The PSD2 (Payment Services Directive 2), adopted in 2018, aims to modernize payment services, enhance the security of electronic transactions, and encourage competition by opening the market to new players such as FinTechs.

<sup>11</sup> Open Banking is an approach that allows banks to securely share their customers' financial data with authorized third parties, such as FinTechs or other financial institutions. This sharing is done through open APIs (application programming interfaces), thereby fostering innovation and the creation of new financial services.

<sup>12</sup> <https://www.economiamatin.fr/news-banque-mutualiste-force-crise-strategie-redacteur>

economies of scale. Furthermore, it is crucial that they quickly adapt to new accounting and regulatory standards, which may require significant investments in training and technologies. Finally, improving governance is essential. Strengthening governance mechanisms would allow for better management of organizational complexity, accelerate decision-making on decarbonization, and ensure more effective implementation of sustainability initiatives. This involves deeply revising decision-making structures, clarifying roles and responsibilities, and increasing process transparency.

#### **4- Conclusion**

European mutual banks stand at a strategic crossroads, where their historical legacy of solidarity, democratic governance, and local engagement must be reconciled with the urgent demands of climate action, digital transformation, and competitive resilience. This study has demonstrated that mutual banks possess unique structural and ethical foundations that align naturally with the principles of sustainable finance. However, these same foundations—particularly their complex governance systems and reliance on public support—can hinder swift and decisive climate engagement.

The comparative analysis of decarbonization targets across European banks reveals a heterogeneous landscape. While some mutual institutions, such as La Banque Postale and Crédit Agricole, exhibit strong climate credentials and transparency, others—like Groupe BPCE and Cassa Centrale Banca—lag significantly behind. This disparity highlights the need to move beyond generalized critiques and adopt a differentiated approach that identifies specific institutional strengths and weaknesses. Using data science tools, such as the t-SNE algorithm, further enriches this perspective by offering a multidimensional view of climate performance, validating NGO concerns while highlighting exemplary mutualist actors.

However, the challenges facing mutual banks extend beyond emissions metrics. Their organizational complexity, rooted in multi-tiered governance and democratic decision-making, often slows the implementation of sustainability initiatives. Regulatory pressures—such as compliance with IFRS 9 and PSD2—compound these difficulties, requiring costly and rapid adaptations that many mutual banks struggle to absorb. Moreover, the rise of Open Banking and FinTech competition exposes the limitations of traditional cooperative models, which must now evolve to remain relevant in a digital-first financial ecosystem.

To address these challenges, mutual banks must pursue a multi-pronged strategy. First, they must strengthen governance mechanisms, streamlining decision-making processes while preserving democratic accountability. This includes clarifying roles, enhancing transparency, and fostering agility in climate-related initiatives. Second, diversifying activities is essential—not only to reduce dependence on public aid but also to build financial resilience and unlock new sources of sustainable investment. Mergers, strategic partnerships, and regional cooperation could help achieve economies of scale and foster innovation.

Third, digital transformation must be embraced not as a threat but as an opportunity. Investing in digital infrastructure, data analytics, and customer-centric technologies will enable mutual banks to compete effectively with more agile institutions while enhancing their capacity to monitor and report on sustainability metrics. Fourth, capacity building—through training, research, and stakeholder engagement—will be critical to embedding climate awareness across all levels of the organization.

Finally, a regional and comparative approach should be adopted to identify best practices tailored to local contexts. Mutual banks operate within diverse national frameworks, and understanding these nuances is key to designing effective reforms. European-level coordination, facilitated by networks such as the EACB, could play a pivotal role in harmonizing sustainability standards and amplifying the voice of mutual banks in global climate finance debates.

In conclusion, mutual banks are not inherently behind in the climate transition—they are unevenly positioned. Their potential to lead in responsible finance is real, but it hinges on their willingness to undergo bold and coherent transformation. By leveraging their ethical foundations, embracing innovation, and reforming governance, mutual banks can become resilient financial actors and champions of a more inclusive and sustainable European economy.

## **REFERENCES**

Apothéloz, C. (2024, November 15). Olivier Pastré: Le modèle coopératif “bottom up” est l’avenir des banques mutualistes. Gomet’. Retrieved from <https://gomet.net/le-modele-cooperatif-bottom-up-est-lavenir-des-banques-mutualistes-olivier-pastre>

Bevilacqua, E. (2022). European cooperative banks and sustainability. – In *Contemporary Trends in European Cooperative Banking: Sustainability, Governance, Digital*

Transformation, and Health Crisis Response (pp. 165–192). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-030-98194-5\\_8](https://doi.org/10.1007/978-3-030-98194-5_8)

Daussy, C., & Courcier, J. (2023). The Mutual Bank Model and Sustainability. – In *Ecological Money and Finance: Exploring Sustainable Monetary and Financial Systems* (pp. 623–649). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-031-14232-1\\_20](https://doi.org/10.1007/978-3-031-14232-1_20)

European Economic and Social Committee. (2018). Europe's Cooperative Banking Models: Revised Edition. Research team: Enrique Castelló, Carlos Trias, and Alberto Arribas. Retrieved from <https://www.eesc.europa.eu/sites/default/files/files/qe-01-18-233-en-n.pdf>

Guider, H., & Roux, M. (2009). La banque coopérative en Europe: stratégies et défis. Revue banque Edition.

Jeffers, E., & Pollin, J.-P. (2012). Déréglementation bancaire des années 1980 et crise financière. *Revue d'Économie Financière*, 105(1), 103–114.

Kosinowski, G. (2020). Cooperative Social Responsibility: A case illustration of the unique character of cooperative governance and its relation to the concept of corporate social responsibility. In *Responsible Business in a Changing World: New Management Approaches for Sustainable Development* (pp. 115-136). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-030-36970-5\\_7](https://doi.org/10.1007/978-3-030-36970-5_7)

Lobre, K., & Cartier, J.-B. (2012). Mutualisme bancaire, hétérosis organisationnelle et difficultés de gouvernance. Papier présenté à la Conférence internationale sur la gouvernance, Lyon, France. (pp. 1–21). <https://halshs.archives-ouvertes.fr/halshs-00696908>.

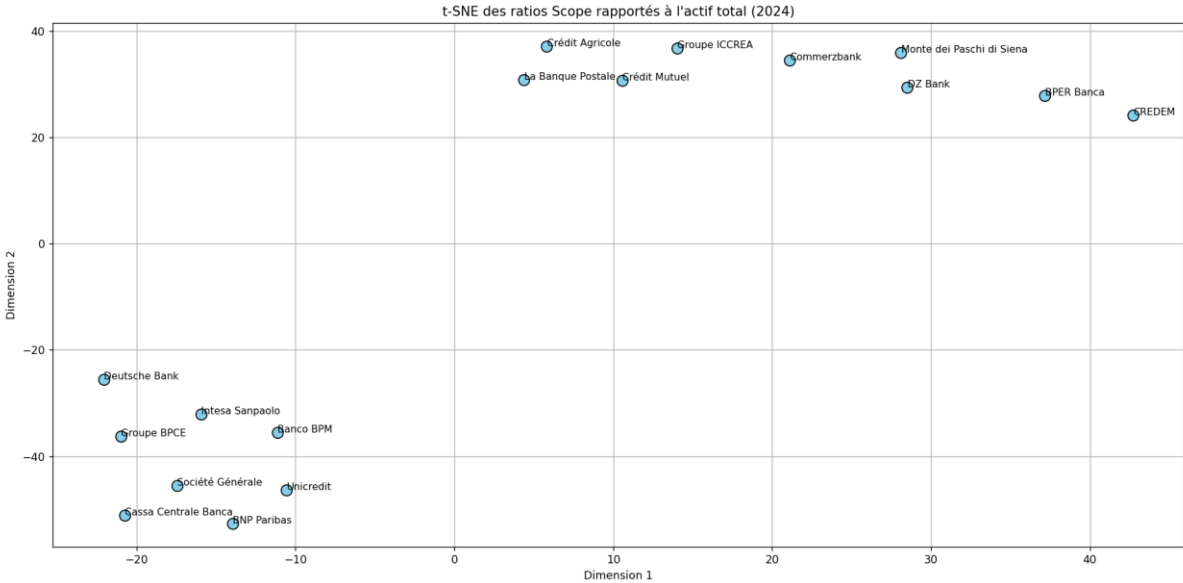
Migliorelli, M. (2018). Cooperative banking in Europe today: Conclusions. In *New Cooperative Banking in Europe: Strategies for Adapting the Business Model Post Crisis* (pp. 231–242). Cham: Springer International Publishing. [https://doi.org/10.1007/978-3-319-93578-2\\_10](https://doi.org/10.1007/978-3-319-93578-2_10)

Moulévrier, P. (2002). Chapitre 1. Les fondements du mouvement coopératif d'épargne et de crédit. Dans le mutualisme bancaire (1- ). Presses universitaires de Rennes. <https://doi.org/10.4000/books.pur.24238>.

Rapport de l'Institut Montaigne (2014). Concilier efficacité économique et démocratie : l'exemple mutualiste. <https://www.institutmontaigne.org/publications/concilier-efficacite-economique-et-democratie-lexemple-mutualiste>

Appendices

Figure 1: T-SNE Cartography for Scopes 1, 2, 3 (2024)



Source: Authors

Notes: The t-SNE algorithm projects high-dimensional data into a two-dimensional space, preserving local similarities between banks based on their CO<sub>2</sub> emissions performance. In this representation, banks positioned in the lower-left quadrant—where both T1 and T2 are negative and fall within the ranges  $T1 \in [-40, -10]$  and  $T2 \in [-60, -20]$ —exhibit similar patterns of poor performance in reducing CO<sub>2</sub> emissions. These institutions tend to cluster together due to shared characteristics such as limited transparency, weak decarbonization strategies, or continued financing of high-emission sectors. Conversely, banks with T1 values between 0 and 20 and T2 values above 20 form a distinct cluster of climate leaders, demonstrating strong alignment in their efforts to mitigate CO<sub>2</sub> emissions.

Their proximity in the t-SNE space reflects common traits such as robust sustainability policies, measurable emission reductions, and active support for low-carbon initiatives.