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Banking, Competitiveness and Sustainability: The Perspective of the Three Global Actors: US, China, Europe

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Abstract

The research presents the interrelationships between banking performance, competitiveness and sustainability of the three banking systems and the impact of each sustainability variable selected on the other macroeconomic indicators in short, medium and long-time horizon. The empirical study involved the use of a panel Auto Regressive Vector methodology and was based on macroeconomic indicators relevant to the performance of the banking system (return on assets, return on equity, an annual growth rate of Gross Domestic Product), as well as indicators that can be assimilated to sustainability (renewable fuels used, CO2 emissions). The dependent variables were return on assets and the annual growth rate of Gross Domestic Product. The global sample analyzed comprises 29 countries, spread over three continents (Europe, North America, Asia), with data collected over a 10-years period (2011-2020). These countries together account for approximately 62% of global GDP (data from 2020). The research results show that as banks invest in green energy and sustainable products, competitiveness will also increase, which will have a negative impact on profitability in the short term. In the medium and long term, this impact will become positive also in terms of profitability increase. This strategic move to develop sustainable business models and to finance a higher percentage of green investments also adds extra competitive advantages, such as reputation and smart differentiation, from other less sustainability-oriented banking systems. The process impacts the systemic level, the macro perspective, the banking organizational level, the micro perspective, together with the perception of the customers.

Keywords: competitiveness, financial crisis, profitability, sustainability, banking performance
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1. INTRODUCTION

The economies of Europe, the United States and China are financed both through banking

systems and capital markets. The different economic fabric, the global footprint of the business conducted by European, American and Chinese companies, and the specific financing needs determine a specific composition for the financing mix used in each of the three global players.

The paper addresses, under the same umbrella, the issues of sustainability and competitiveness. Competitiveness is a key element at individual, organizational, country or regional levels. The complexity of this concept, and the multitude of perspectives from which it can be approached, offer the opportunity for extensive research.

From the perspective of this research, the competitiveness of the three banking systems will be analyzed by selecting specific indicators. The period analyzed in the empirical study is, in fact, the post-financial crisis period, the period between two crises, the global financial crisis and the pandemic crisis. It provides significant changes in financial-banking governance, technological developments, and behavioral changes along with ingredients of interest for structuring mechanisms, response tools, and future policy mix. In addition to the competitiveness component, research also adds a sustainability component.

From a strategic perspective, it is appropriate that the level of competitiveness of a banking system, specific to a country or an economic and monetary area, is transferred to that economy or economic area and the economic actors.

The relevant literature includes growth models that emphasize competitiveness as one of the key elements for economic development, for the creation of economic value.

Sustainability is another key concept for present and future national and international policies. The governance of this concept and its effective implementation represents a complex process, based on the coordination of many actors, with long-term impact.

The competitiveness-sustainability approach brings a certain degree of novelty and sensitivity to scientific research to the economic debate: does the transition to a new, "green" economy implies maintaining, and strengthening the competitiveness of companies and economies? Is this transition realized in a sustainable manner for the financial-economic architecture of a company/country/region?

Representative initiatives that have argued and supported sustainability issues include the United Nations and the promotion of the Sustainable Development Goals, linking business to solutions to major social and environmental policy problems.

Other milestones for the beginnings of the sustainability approach are the Paris Agreement of 2015, also taken up by governments, central banks, financial supervisors, and the issuance of the first "green" bond by the European Investment Bank.

The impact of climate change on economies is not always noticeable. The rising costs of extreme weather events, reputational and legal risks from lawsuits against companies that do not comply with environmental regulations, developments in fossil fuels and regulatory risks for companies that do not contribute to reducing their carbon footprint are driving a complex set of relationships between authorities, companies, central banks, financing banks, investors, and producers of new and innovative technologies.

Competitiveness and sustainability must be integrated synergistically into future policies. But

the manner of integration, and the perspectives from which it is achieved, must be underpinned both by scientific research, international best practice and articulated economic development programs, with appropriate long-term financial support mechanisms.

To highlight the complex spectrum of this issue, we have selected a number of representative profitability and sustainability indicators specific to the three selected banking systems. The empirical analysis of this extended period, post-global financial crisis, the dynamics of regulatory, technological and environmental changes allowed us to take a broader approach to the correlations between the variables selected.

The article analyses the interrelationships between the three variables used - return on assets, return on equity and the growth rate of Gross Domestic Product, relevant indicators at the level of banking systems, including from a competitiveness perspective. In addition to these three indicators, two other indicators can be assimilated into sustainability, such as the volume of renewable fuels used and the amount of CO2 emissions.

The research contributes to the enrichment/development of the literature by conducting an empirical study on the correlations between profitability and sustainability variables based on a panel VAR model. The identification of exogenous shocks, generated both by the number of renewable fuels used and Co2 emissions on return on assets, return on capital and the GDP growth rate are highlighted in this research.

2. THEORETICAL BACKGROUND

Competition is essential and beneficial both at the level of banking systems and in the area of digital finance, as long as it is fair and brings important benefits to society and financial systems. A major obstacle to the competitiveness of European banks is market fragmentation. This is also combined with the need for harmonization between 27 different supervisory regimes and authorities.

The US and EU financial markets are different in terms of funding: the US market relies heavily on retail investors and the equity fund market, while the participation of EU retail investors in the capital markets remains low, making the competitiveness of the two banking systems and their financial performance different.

In Europe, by comparison, most financing is channeled via traditional credit institutions, which has important implications for how companies raise external finance. As a result, in the US banking market, much more capital is raised directly from the capital markets, through the issuance of bonds and other securities, than through conventional bank loans, which remain on banks' balance sheets until maturity (Yip & Bocken, 2018; Hachenberg & Schiereck, 2018).

According to the research of Gao et al. (2019) and Su et al. (2020), in comparison with the European and American banking systems, the Chinese banking system has an open market entry for companies. It is also high competition among banks because depositors can search for high-yielding assets, comparing traditional banking with shadow banking and capital market.

According to Iacovoiu & Stancu (2017), and Monti et al. (2020) the concentration of banking markets and competition are essential for a welfare public policy in the banking market. Thus, in

order to foster competition in the banking sector and increase the effectiveness of competition measures, regulators and competition authorities need to adopt consistent and appropriate policies for the regulation of the banking sector (Belas et al., 2012) and the banking services market. In this context, Belas et al. (2014) emphasize the importance of customer satisfaction, which also affects the efficiency and competitiveness of commercial banks.

Nitescu et al. (2019) and Nitescu & Cristea (2020) show that at the European Union level, there is a need for strategic positioning and highlighting competitive advantages over other global players, especially the US and China.

To respond adequately to digital challenges, cyber and other risks associated with technological innovation, climate change and climate-induced risks, this must be supported by adequate financial resource allocation mechanisms, a trained and educated workforce that can accumulate and use new skills, and the ability to build new strategic relationships (Mullan et al., 2021).

Thus, social and environmental sustainability is one of the most significant trends in the financial markets in the last decade. The integration of sustainability criteria implies the design and development of new business models adapted to each company and bank.

Moreover, Scholtens & Van't Klooster (2019) found that banks with high sustainability scores, especially in the social dimension, have a lower default risk and a lower contribution to financial system risk.

The research of Gangi et al. (2019) and (Hachenberg & Schiereck, 2018) highlights that the banking sector can play a crucial role in sustainable activities. Banking has a higher impact on the sustainability of other industries through the lending channel, whereby banks can get directly involved in projects that protect the environment, can channel funds to support the environmental risk of the targeted companies, or promote socially sustainable products.

According to Fay (2020), Capgemini (2020), alongside social initiatives, environmental initiatives are also well received by customers. Banks offer green financial products, and customers purchase more banking products and allocate larger investment budgets. In addition, Sun et al. (2020) reported that green banking initiatives strengthen the relationship between corporate social responsibility and consumer loyalty.

According to EY (2020) and Finextra (2022), focusing on maximizing stakeholder value and customer satisfaction by mitigating the harmful effects of economic activities on the environment and society represent a strategic objective for a particular category of banks that are considered sustainable banks. The Global Alliance for Banking on Values (GABV) also stresses that sustainable banks can achieve high profitability by attracting resources, significant deposits and funding. Their yields are considered stable, focusing on medium and long-term profitability.

This banking business model also involves specific challenges. The way in which sustainable responsibilities are not achieved at the expense of increasing costs and reducing efficiency, with a focus only on social and environmental investments, also needs to be assessed (Desender et.al., 2020).

Other research by Bussoli et al. (2018) Gurnani, (2020) highlights that sustainable practices can also be valuable assets that directly contribute to recovering bank efficiency. A good and

strong relationship with all stakeholders can help sustainable banks to identify a diversity of investments, which access and use more efficiently, attracted resources.

Sustainability can also enhance banks' reputation and customer loyalty, contributing to lower funding costs. According to the research by Bertoncelj (2022), one of the EU priorities and a major concern for policymakers, industry and academia, as the European Union is currently facing several economic, social and environmental challenges, are related to the transition from a linear to a green economy.

Bratucu et al. (2022) and Nosratabadi et al. (2020) show that to cope with global climate change, the European Commission has developed the European Green Pact (EGP), in which the shift to green energy requires significant changes. Banks and firms will have to develop innovative business models based on clean and increasingly digitalized technologies to contribute to the sustainable transformation of the EU economy.

At the level of the Chinese banking system, the inclusion of environmental concerns in banking regulations started as early as 1995 and gradually developed, expanding rapidly after 2015. Relevant research by Choi et al. (2020) shows that policymakers in China are at the forefront of green banking policy innovation. After the release of the Guidelines for Establishing Green Financial System in 2016, innovation in the Chinese banking system expanded rapidly. Chinese banks, for example, are showing increased diversity by using specialized instruments, collateral methods, asset-backed securities and international green credit lines.

In the papers by Tan & Lee (2017) and Goodman et al. (2017), it is emphasized that following 2015, with the Paris climate agreement, the United States announced the intention to achieve an ambitious economy-wide goal.

As both the US and China have different levels of development, each will be pursuing different intermediary objectives to reach the proposed targets by 2025 and, respectively, by 2030, Charlton (2017). Those targets commit to reducing CO2 emissions by 26-28% below 2005 levels by 2025 for the US and to make every effort to reach the 28% emissions reduction threshold.

In order to achieve their respective emissions targets, both China and the United States use a portfolio of policy instruments, from mandates and command-and-control standards to market mechanisms Cornett et.al (2016).

3. RESEARCH OBJECTIVE, METHODOLOGY AND DATA

The research aims to present the interrelationships and shocks over different periods of time between indicators of competitiveness, profitability and sustainability, answering a complex question: how sustainability, profitability and competitiveness indicators can impact the specific banking systems in the US, China and Europe?

To build an adequate framework to answer this complex question, including the five selected variables presented in Table 1, and to highlight the interrelationships between the indicators used, we have formulated three hypotheses:

H1. The indicators used have a significant impact and influence, in a relevant manner, the bank's profitability.

H2. Renewable fuels and the reduction of CO2 emissions have a negative impact on banking competitiveness.

H3. The indicators used in the research have a lower impact on the evolution of profitability indicators.

29 countries from three continents, Europe, North America and Asia, were selected for this research. The World Bank database was used as the data source from Global Financial Development 2022) and World development indicators (2022).

The period of data analysis was 10 years, from 2011-2020. The period was chosen to analyze the strategic impact on competitiveness related to the evolution of the three global banking systems, after the financial crisis and until the onset of the pandemic crisis, in 2020. The choice of these countries was based on the fact that they play a significant role in the global economy, accounting for USD 53 trillion of global GDP in 2020, representing around 62%.

The methodology used in this empirical study included 290 observations involving the use of econometric modeling using Eviews 12. Thus, in the linear regressions and subsequently, in the Vector Auto Regression (VAR) framework, all the data series that were used had annual frequencies and the countries selected for analysis and testing had different degrees of development. The VAR model was used because it best captures the interrelationships and shocks between the selected variables, over different periods of time, in our case for 29 countries, over 10 years, being split into the short, medium and long term.

For this research, a quantitative mix of financial instruments was used to identify the evolution, influences and impact of some important macroeconomic indicators for bank performance, considering, in turn - two dependent variables (return on assets and the GDP growth rate) and measuring the impact on them, of the other variables, used (amount of renewable fuels used, CO2 emissions and return on equity).

The research was conducted by measuring the impact of each independent variable on each dependent variable over a short, medium and long-time span in the context of both the global financial crisis and the pandemic crisis.

The characteristics of each selected variable were evaluated to obtain the optimal analysis methodology for estimating linear regression and VAR models, which involved the identification of basic characteristics for the data series and the testing of specific hypotheses for each type of model used.

To obtain the most relevant results, both statistically and economically, we chose to use two endogenous variables (return on assets and the GDP growth rate). All variables used in the empirical study are presented in Table 1.

Tab. 1 – Macroeconomic indicators used in the analysis. Source: own research

Variable Type	Variable Name	Description
Endogenous	D(ROA)	Return on assets (expressed as a percentage).
	D(GDP_Growth)	GDP growth rate (expressed as a percentage).

Exogenous	D(Combust_renew)	Amount of renewable fuels used (stated as % of total fuels used).
	D(CO2_EMIS)	Amount of CO2 emissions (expressed as % of total greenhouse gases).
	D(ROE)	Return on equity (expressed as a percentage %).

The sample of countries selected for the empirical study includes European countries plus the US and China. The selected European countries are Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italia, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden.

4. RESULTS AND DISCUSSION

To identify the significance of the variables used in both the short and long run, we used the Vector Autoregressive Distributed Lag (VARDL) cointegration test presented in Figure 1. (In Annex).

Following this test, considering, in turn, as dependent variables (return on assets and the annual growth rate of gross domestic product), we can note that some of the variables are significant in the short term, as the case of the relationship between ROA and ROE variables. The sustainability variables, CO2 emissions and volume of renewable fuels, are statistically insignificant in this case. In the long term, the statistically significant variables are return on assets, the annual GDP growth rate, CO2 emissions and volume of renewable fuels.

In this analysis, an important role is revealed by the size of the percentages of the significance of the sustainability variables on the profitability variables in the short, medium and long term. The Autoregressive Distributed Lag (ARDL) model was based on the Akaike Information Criterion (AIC). According to Figure 1, both positive and negative relationships can be identified with respect to the 5% significance threshold.

Thus, in the short term, at a 1% increase in CO2 reduction, return on assets will increase by 0.01%, and at a 1% increase in the number of renewable fuels used, return on assets will increase by 0.132%. At a 1% increase in return on capital, return on assets will increase by 0.035%.

In the case of a 1% increase in the number of renewable fuels used, an increase in the GDP growth rate of 0.523% is emphasized by the analysis. Also, at a 1% increase in the return on capital, the GDP growth rate will decrease by 0.053%. At the 1% increase in the reduction of CO2 emissions, the GDP growth rate will increase by 0.187%.

In the long term, for a 1% increase in CO2 emission reductions, the return on assets will decrease by 0.03%, while for a 1% increase in the number of renewable fuels used, the return on assets will decrease by 0.95%. For a 1% increase in return on capital, return on assets will increase by 0.034%.

Also, in the long term, the output of the test reflects that a 1% increase in the reduction of CO2 emissions will increase the GDP growth rate by 0.07%. A 1% increase in the number of

renewable fuels used will contribute to increasing the GDP growth rate by 0.14%, while a 1% increase in the return on capital will increase the GDP growth rate by 0.01%.

Figure 1 reflects that, despite the short-term impact on endogenous variables, the long-term impact of sustainability and profitability variables on return on assets and the GDP growth rate is predominantly positive.

The analysis was extended to a group of countries considered representative in terms of the values for the selected indicators of the empirical study: within the EU 27 - France, Germany, Italy, Spain, respectively the US and China. For almost all the countries in the EU 27 and the US, the statistically significant variables in the short term are CO2 emissions, the volume of renewable fuels, return on assets and the GDP growth rate, meaning that ROA and GDP growth are the same dependent variables. As reflected in Figure 2, the most significant impact of a variable is on itself, which indicates that interrelationships and shocks between variables indirectly affect the dependent variables, and the impact is not significant from a statistical perspective. All of them are below the 5% significance threshold.

For the US banking market, the short-term return on assets is statistically insignificant, with a probability of 64.03%, well above the 5% significance threshold. This reflects that from an economic point of view, the CO2 emissions variable has a small impact of 0.05% and the volume of renewable fuels has an impact of 0.06%.

In the case of China, the return on assets is statistically insignificant at 87.63%. In the case of France, it is insignificant at 10.15%, both above the 5% significance threshold, while for Germany, the return on assets indicator is insignificant with a probability of 40.62%. For Spain, the return on assets is statistically significant, being below the 5% significance threshold (Ruiz et al., 2016). For Italy, the return on assets is also statistically insignificant, with a probability of 71.65%, well above the 5% significance threshold.

This suggests that the impact of sustainability variables is low, this output of the research being in line with the other relevant studies. Thus, increasing the use of renewable energy sources and technologies, as well as their integration into the banking systems, can have a significant, positive impact in the medium and long term, as reflected by Finextra (2022).

In Figure 2, the variance decomposition was used to identify the proportion of the variation of the dependent variables, explained by each independent variable used, and to analyze the percentage impact of the sustainability variables on the profitability of the three banking systems. Figure 2 reflects the most substantial impact registered when a direct shock is applied to the return on assets. For each variable analyzed, the short-term range is considered (1-2 years), the medium-term range is (3-5 years), and the third range is considered (5-10 years).

In the short term, a shock applied to the dependent variable return on assets, reflecting the most substantial impact, being 98.58% in the second year. Also, in the long term, it remains with a significant impact of 97.25%. This indicates the positive impact of other relevant variables of the banking business, such as net interest margin and capital adequacy ratio. The impact in the short term, also for 2 years period, is 0.24%, being registered for the variable return on equity. Even after 10 years, it remains at 0.44%. For the Hypothesis 1, the variables used do not have a significant and direct impact on bank profitability. The more banks invest in sustainability and

offer a wider range of competitive and sustainable products, the more they will have a significant impact on profitability in the medium and long term, so the Hypothesis H1 is rejected. The variables of return on assets and GDP growth significantly affect its own variables in the short, medium and long term.

The impact of using renewable fuels and CO2 emissions is low in the short term. In the medium term (3-5 years), the impact is also low on the return on assets, as the effect of the sustainability variables, the number of renewable fuels being 0.27% and CO2 emissions being 2.04%.

In the long term, the results reflect that for a 1% change in the number of renewable fuels used, the return on assets varies by 0.27% and for a 1% change in the reduction of CO2 emissions, the return on assets varies by 2.04%. The more significant the investments in renewable energy, even if the short-term impact is predominantly negative, the more positive the long-term impact will be. The analysis shows that for a 1% change in CO2 emissions, the GDP growth rate varies by 1.63%, and for a 1% change in the number of renewable fuels used, the GDP growth rate varies by 1.5%. For the 1% change in the amount of renewable fuels used in the medium term, the GDP growth varies by 1.49%, and for the 1% change in CO2 emissions, the GDP growth varies by 1.62%. Over both the medium and long-time horizon, the number of renewable fuels used, and CO2 emissions remain at a low level of direct significance on profitability and the GDP growth rate.

Hypothesis H3 is confirmed since investments in green energy and reducing the carbon footprint are still in early stages. Variables such as the number of renewable fuels used, and CO2 emissions remain at a low level of direct significance and impact on profitability and the GDP growth rate.

The slow implementation of using renewable resources in banking is linked to the behavior and understanding of the customers as well as to the international best practice and sector standards. Risk management, both at the macro and micro levels, plays a key role in adopting green technologies (Torre Olmo et al., 2021).

The increase in the volume of credits allocated to green investments and green mobility is another important aspect, so the effects of increasing the amount of alternative and green energy financed by banks at a global level are directly transmitted to the reduction of carbon emissions, by replacing polluting energy sources (coal and fossil fuels), Nizam et al. (2019). These issues in the context of both the post-global financial crisis and the pandemic crisis are empirically validated by the Paris Agreement, which aims to reduce carbon emissions by 45% by 2030, compared to 2010 levels, to limit global warming by 1.5 degrees Celsius.

The analysis of sustainable practices needs to be done in a broader context, given that the global financial crisis of 2008 led banks to adopt sustainable activities but also reduced bank profitability and increased bank concentration as a result of mergers and acquisitions.

This reinforced the differences between the more efficient and less efficient banks, as the more efficient banks received reductions in lending costs, thus obtaining better financing conditions. In addition, more efficient banks that develop sustainable business models also gain competitive advantages such as a good reputation and brand differentiation from less sustainable banking brands, leading to attracting loyal customers, green investment-oriented investors and increasing market share (Zhang et al., 2022).

Hypothesis 2 (H2) is partially confirmed because the negative impact in the short term will affect competitiveness by investing in sustainable projects and renewable energy, compared to counterparties that do not invest in sustainability at all. In the long term, this impact will become a positive one for banks that have invested in green energy, leading to attracting more sustainable investment-oriented investors, brand loyalty and increased market share (Jagannathan et al., 2017; Harjoto & Laksmana, 2015; Krueger et al., 2020; Pástor et al., 2021).

The results of our research highlight the existence of a cointegrating relationship between sustainability and profitability indicators for most of the countries analyzed, which have a negative impact in the short term, but a positive one in the medium and long term, even if it is reduced in intensity. Some of the variables, although statistically insignificant, are economically significant, highlighting that the development of sustainable business models in global banking is still in its infancy and that the impact of sustainability variables is transmitted mostly indirectly to the dependent variables, suggesting that the volume of investment in renewable energy should be increased. The result is in line with another relevant research, such as Rehman et al. (2020).

From the perspective of a transition to a low-carbon economy, with a positive impact on profitability and economic growth, central banks need to consider a steady and gradual process. This process will not generate sudden increases in energy costs and rapid depreciation of fossil reserves, which contribute to lower market value for banking systems with exposures to high carbon resources and technologies, otherwise making the transition to sustainability very costly in terms of profitability.

Figure 3 represents the impulse response function and reflects the impact of shocks on each dependent variable (return on assets and the GDP growth rate) as well as the correlations between them and other independent variables used in the model.

Thus, the shock to return on assets from the number of renewable fuels is positive in the first two years and negative over a medium timeframe (2-4 years). The impact is low and returns to steady after a 5-year interval. Similarities are also observed on the GDP Growth variable, as the impact of the independent variables, with slightly positive and then negative fluctuations, in the first 4 years. From year 5, it returns to a steady state.

These results indicate that banking systems that best integrate corporate, social and environmental governance under the umbrella of Environmental, Social and Governance principles (ESG) are striking the right balance between short, medium and long-term priorities. Those banking systems will be in a position to reduce their risks and generate profitable growth, according to Chang et al. (2021).

Starting from recycling and reusing resources, global banking systems need to rethink their business strategies, given that numerous reports indicate a direct correlation between sustainable practices, share prices and business performance, as Tornjanski et al. (2017) state.

Furthermore, banks that have ESG principles integrated into their medium and long-term growth strategy will also be able to generate profitable growth by investing in sustainable innovations that have a positive impact on the world. Through improved and appropriate corporate governance, they can attract the best influencers and build effective marketing campaigns, according to Shao et al. (2020).

Banks need to focus their investments predominantly on "green" companies, and this can also be used as leverage by banks to approve loans or even refuse them when financing companies that are less sustainable. Although, in the short term, the financial performance of global banking systems may suffer, in the long term, it will prove to be an important strategic decision, as Dedu et al. (2021) state.

The banking sector can send available funds towards investments in sustainability and renewable energy at a faster pace, thus having a significant impact on the transition of today's economy towards a "green" economy. Banks, via specific banking products and services, may provide financial support to educate and influence customer preference for investments in sustainable projects.

Banks and other financial institutions will face strong transparency pressures on how climate change risks may impact their assets and business models. Cooperation, not competition, is the key to value-added in the long run. The global financial and banking sector, mixing equity and debt, represents the main allocator for capital to sustainable investments and technologies. Cooperation between the three global actors under an international regulatory framework may lead to relevant results in terms of balancing sustainability and competitiveness.

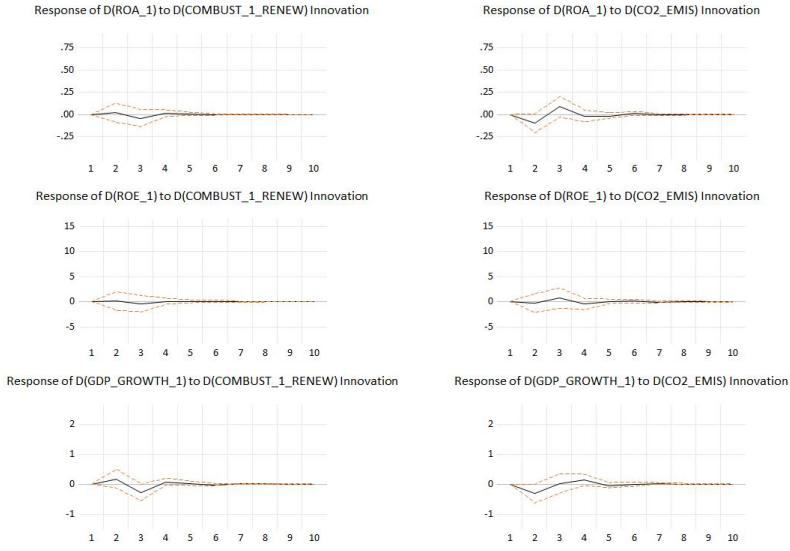

Fig. 3 – The reaction of dependent variables to shocks from independent variables and the relationships between variables. Source: own research

In this context, it should be a concern to create viable solutions to reconcile increased competition with the ESG principles while improving the quality of financial information in the banking sector, linked in a compatible manner with antitrust law.

Finally, if the reality of promoting sustainability objectives creates significant tensions with antitrust law, governments in each country may decide between competing public policy objectives by amending antitrust laws to take greater account of the need to meet the medium- and long-term sustainability objectives.

5. CONCLUSION

The process of integrating banking profitability and competitiveness, together with sustainability, represents important challenges for the banking systems of the three global actors: the US, China and Europe.

Transforming these challenges into strategic solutions can be achieved through a new mix of economic, monetary, environmental and competition policies, which must be tailored specifically to the structure of each banking sector, but convergent and consistent, under an international umbrella.

The environmental, corporate governance and social factors, integrated within the global banking systems, represent benchmarks for future "green" banking, convergent with the new economy.

This strategic move to develop sustainable business models and to finance a higher percentage of green investments also add extra competitive advantages, such as reputation and smart differentiation, from other less sustainability-oriented banking systems. The process impacts the systemic level, the macro perspective, the banking organizational level, the micro perspective, together with the perception of the customers.

The relevant contribution of the paper is represented via its innovative approach, tackling a very new and important problem, such as sustainability, linking it with banking and competitiveness. Especially sustainability which is a new and relevant topic for policy, the economy and society does not have a relevant track record based on data gathering to support deeper statistical research. The approach to this topic needs consistent research from various angles to contribute and channel a valuable implementation, adding value to the economy and society.

The research highlights the important role of sustainability and the variables used in this respect on bank competitiveness and profitability, as well as their degree of interconnection with other variables selected, in which the central role is played by carbon footprint reduction. The results of the empirical study are in line with other relevant studies and research work.

The reduction of carbon dioxide emissions must be integrated with digitization, and the use of renewable energies, to have a significant impact on the profitability, competitiveness and performance of banks in the medium and long term. But despite the risks of reduced profitability in the short term, investing in sustainable solutions, energy efficiency and low carbon initiatives has a direct effect on profitability, leading to superior financial performance in the medium and long term, conserving natural resources as well as the climate.

Sustainable and digital finance may contribute to the "competition", impacting economies and communities, integrating innovation, providing support for new jobs creation, and acting as an essential catalyzer for the transition to a "green" and sustainable economy.

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ANNEX

Dependent Variable: D(ROA_1,2)
Method: ARDL
Date: 05/02/22 Time: 21:10
Sample: 2011 2020
Included observations: 290
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): D(ROE_1) D(COMBUST_1_RENEW) D(CO2_EMIS)
Fixed regressors: C
Number of models evaluated: 1
Selected Model: ARDL(1, 1, 1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
D(ROE_1)	0.034361	0.000831	41.34103	0.0000
D(COMBUST_1_RENEW)	-0.095107	0.016785	-5.666262	0.0000
D(CO2_EMIS)	-0.028607	0.007965	-3.591499	0.0004
Short Run Equation				
COINTEQ01	-0.532049	0.126024	-4.221795	0.0000
D(ROE_1,2)	0.034887	0.011077	3.149593	0.0019
D(COMBUST_1_RENEW,2)	0.132793	0.107124	1.239627	0.2168
D(CO2_EMIS,2)	0.012216	0.014224	0.858856	0.3916
C	0.050381	0.023716	2.124348	0.0351
Root MSE	0.497628	Mean dependent var		-0.005831
S.D. dependent var	1.927004	S.E. of regression		0.679676
Akaike info criterion	-0.629429	Sum squared resid		78.99514
Schwarz criterion	1.117431	Log likelihood		248.3939
Hannan-Quinn criter.	0.068202			

*Note: p-values and any subsequent tests do not account for model selection.

Dependent Variable: D(GDP_GROWTH_1,2)
Method: ARDL
Date: 05/02/22 Time: 21:13
Sample: 2011 2020
Included observations: 290
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): D(ROE_1) D(COMBUST_1_RENEW) D(CO2_EMIS)
Fixed regressors: C
Number of models evaluated: 1
Selected Model: ARDL(1, 1, 1, 1)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Long Run Equation				
D(ROE_1)	0.013028	0.003013	4.323144	0.0000
D(COMBUST_1_RENEW)	0.140886	0.162525	0.866858	0.3872
D(CO2_EMIS)	0.071743	0.030546	2.348685	0.0200
Short Run Equation				
COINTEQ01	-1.051877	0.225414	-4.666417	0.0000
D(ROE_1,2)	-0.053040	0.031645	-1.676090	0.0955
D(COMBUST_1_RENEW,2)	0.523268	0.492981	1.061436	0.2900
D(CO2_EMIS,2)	0.187155	0.198302	0.943787	0.3466
C	0.086011	0.069505	1.237489	0.2176
Root MSE	1.918443	Mean dependent var		0.442833
S.D. dependent var	4.457894	S.E. of regression		2.620271
Akaike info criterion	3.891483	Sum squared resid		1174.055
Schwarz criterion	5.638343	Log likelihood		-472.6916
Hannan-Quinn criter.	4.589114			

*Note: p-values and any subsequent tests do not account for model selection.

Fig. 1 – VARDL Test. Source: own research

Variance Decomposition of D(ROA_1):					
Period	**S.E.**	**D(ROA_1)**	**D(ROE_1)**	**D(COMBUST_1_RENEW)**	**D(CO2_EMIS)**
1	0.833884	100	0.000000	0.000000	0.000000
2	0.935141	98.57875	0.243547	0.056475	1.121226
3	0.940382	97.50437	0.252789	0.251901	1.990941
4	0.945726	97.33033	0.406243	0.261909	2.001515
5	0.946384	97.28748	0.422071	0.26343	2.027023
6	0.946541	97.2599	0.432511	0.265302	2.04229
7	0.946603	97.25025	0.442163	0.265286	2.042298
8	0.946606	97.24964	0.442347	0.265337	2.042675
9	0.946609	97.24898	0.442895	0.265343	2.042783
10	0.946611	97.24877	0.44311	0.265343	2.042778

Variance Decomposition of D(GDP_GROWTH_1):					
Period	**S.E.**	**D(GDP_GROWTH_1)**	**D(ROE_1)**	**D(COMBUST_1_RENEW)**	**D(CO2_EMIS)**
1	2.439923	100	0.000000	0.000000	0.000000
2	2.715371	98.18424	0.011899	0.398424	1.40544
3	2.737731	96.60177	0.568743	1.446003	1.383483
4	2.7613	96.03032	0.894359	1.492609	1.58271
5	2.764008	95.98447	0.901803	1.492548	1.621178
6	2.764387	95.96513	0.912282	1.500565	1.622025
7	2.764743	95.95632	0.917311	1.500524	1.625846
8	2.764765	95.95582	0.917372	1.500656	1.626151
9	2.764774	95.95549	0.917553	1.50076	1.626197
10	2.764778	95.95538	0.917622	1.500757	1.626243

Fig. 2 – Numerical correlations between variables. Source: own research