1. Research project title

The banking sector facing the challenges of climate change: how new frontiers in machine learning, econometrics and statistics can help in the identification and management of credit and operational risk

2. Duration (months)

24 months

3. Main ERC field

SH - Social Sciences and Humanities

4. Possible other ERC field

5. ERC subfields

1. SH1_4 Finance; asset pricing; international finance; market microstructure
2. SH7_6 Environmental and climate change, societal impact and policy
3. SH1_6 Econometrics; operations research

6. Keywords

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3. Bank's credit risk
4. Machine learning and econometrics
5. Climate change
6. Climate-related risks

7. Principal Investigator

NAVA
(Surname) CONSUelo RUBiNA
(Name)

Ricercatore a t.d. - t.pieno (art. 24 c.3-b l. 240/10)
(Qualification)

OMISSIS
(Utente)

OMISSIS
(Personal Identification code)

Università degli Studi di TORINO
(Organization)

OMISSIS
(E-mail address)

PI - Certified E-mail (CEM)

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Age limits derogation

Both the PI and the substitute are under 40;

8. List of the Research Units

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<td>Ricercatore a t.d. - t.pieno (art. 24 c.3-b l. 240/10) (data fine contratto: 21/12/2023)</td>
<td>Università degli Studi di TORINO</td>
<td>Via Verdi, 8 - TORINO (TO)</td>
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MUR - BANDO 2022
9 - Substitute Principal Investigator (To be identified among one of the associated investigators participating in the project).

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<td>Largo Gemelli, 1 - MILANO (MI)</td>
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<td>Via dei Vestini, 31 Campus Universitario - CHIETI SCALO (CH)</td>
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<tr>
<td>City: Pescara (PE)</td>
<td>Address Viale Pindaro 42, 65127 Pescara</td>
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(adesione completata il 28/03/2022)
10. Brief description of the proposal

Climate-related risks are relevant for the banking sector given that through economic (micro and macro) transmission channels, they generate financial risks for banks. Therefore, understanding climate risks and how they translate into financial risks has become of great interest to financial authorities and financial actors, at the point that banks are facing increasing pressure to identify and manage financial risks related to climate changes.

This project, in general, aims at mapping climate-related risks and analyzing how exposure to these risks leads to bank credit and operational risks.

Thus, we will first elaborate a mapping of climate-related risk drivers, in the form of physical and transition risks, which could affect financial risks of banks directly or indirectly (arising from their borrowers’ exposures).

With respect to the credit risk, we will identify the exposure to (climate-related) transition risks of the potential bank financed firms, through the proposal of a novel and more exhaustive indicator, namely a resilience score. It will be based not only on GHG emissions but will account also for further dimensions such as company’s negative impacts in terms of pollution, waste production and water usage, as well a measure of technological adaptation delays, as circumstances capable of slowing the transition towards a more sustainable economy and threatening the medium to long-term survival of firms. Based on this resilience score and considering also the mapping of geopolitical risks, we will investigate their effects on bank credit risks.

With respect to the bank operational risk, we will investigate and estimate bank’s potential direct exposure to climate-related physical risks. Moreover, we will stress the degree of banks’ perception of exposure to geopolitical risks intensified by climate change as a source of operational risk. Finally, to provide a better foundation to a bank’s mapping effort, we will elaborate guidelines for a granular exposure analysis of physical risks that can generate operational risks for the financial institution, considering the banks’ different business lines and operations, locations of bank’s subsidiaries and their activities, and location of services providers for outsourced services.

Empirical analyses, conducted to achieve the stated goals, will propose cross-country and sectors comparison, with different level of granularities. We will leverage a wide range of methodologies, ranging from in-depth case studies and national/international surveys development to the use, construction, and integration of econometric’s, statistics, and machine learning techniques.

11. Total cost of the research project identified by items

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N.B. The Item B and TOTAL columns will be filled in automatically

- item A.1: enhancement of months/person of permanent employees
- item A.2.1: cost of contracts of non-employees, specifically to recruit
- item B: overhead (flat rate equal to 60% of the total personnel cost, A.1+A.2.1, for each research unit)
- item C: cost of equipment, tools and software products
- item D: cost of consulting and similar services

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PART B

B.1

1. State of the art

The financial system, but more specifically sustainable finance (the process of integrating environmental, social and governance (ESG) criteria or considerations when making financial decisions), plays a key role in fighting global warming, in pursuing the Paris Climate Agreement goals, and in transforming the global economy into a greener and more sustainable system (Schoenmaker and Schramade, 2018; Weber and Remer, 2011). In the European context, the European Commission’s (EC) Action Plan on Financing Sustainable Growth adopted in March 2018 and the goal of carbon-neutrality by 2050 set out in the European Green Deal in December 2019 clearly emphasize the role of the financial system (Busch et al. 2021; Clayes et al. 2019).

From the perspective of this project, two strategic objectives of the Action Plan are relevant: i) reorienting capital flows towards a more sustainable economy, and ii) managing financial risks stemming from climate change, resource depletion and environmental degradation.
Climate change and climate-related risks are concrete threats to economies and financial systems. Climate-related risks are usually categorized in two types: physical and transition risks, each with its unique features (BCBS 2021a, ECB 2020, 2021; EBA 2021; Ferrazzi et al. 2021).

The former is typically defined as risks that arise from the material effects of climate change. They can be acute, if they arise from extreme weather events or severe environmental deterioration (floods, cyclones, storms, wildfires, landslides), or chronic if associated with gradual, progressive climate shifts in climate such as rising temperatures and sea levels, water stress, loss of biodiversity, and scarcity of resources (NGFS, 2019). Physical risks tend to be distributed differently across geographical locations, some being more vulnerable than others.

The second category of climate-related risks are the transition risks; they derive from the adjustment process to a low-carbon and more sustainable economy which leads to policy and technological changes, as well as to shifts in consumer preferences toward a greener and “healthier” planet. However, some of the existing business models might not be able to adapt and remain competitive (BCBS, 2021). Both types of climate-related risks generate impacts of economic significance. Physical risks cause damage to properties, assets, production capacity and interruptions in supply chains. Transition risks can lead to stranded assets, reputational damage and to the phasing out of some activities.

In recent years, academics, central banks, and international institutions have published many studies that recognize climate-related risks as relevant for the financial system and, within it, for the banking sector this project refers to (Brei et al. 2019; BCBS 2021; ECB 2020; FSB 2020). Climate-related risks generate financial risks that affect financial institutions and banks, mostly through economic (micro and macro) transmission channels (Brunetti et al. 2021; ECB, 2021; NGFS, 2020).

Banks’ exposure to climate-related risks leads to financial risks, alternatively or simultaneously in terms of credit risk, market risk, operational risk, and liquidity risk. The exposure can be indirect (for example through loans to borrowers) or direct (for example in the case of a financial service interruption from an extreme natural event). The literature, on the one hand, explicitly states how crucial the consideration of climate-related risks is for bank risk management while, on the other hand, it reports that much remains to be done in terms of methodological and empirical investigation. The outstanding issues to address include the collection of granular and forward-looking data to map the exposure of banks to climate-related risks, the modelling of the behavior of climate risk drivers and the quantitative assessment of the identified climate-related risks impacts on banks.

In this perspective, the key risks of a bank impacted by climate-related risks that we consider in this project are credit risk (the distinctive risk associated with the bank’s role in the indirect financial intermediation channel) and operational risk (on which up to now there has been a very limited focus). The selected issues are relevant both at the bank level and for the banking system as a whole, for its stability and regulation.

**PROJECT POSITIONING:** Measurement and assessment of climate-related risks implications for the banks’ credit and operational risk.

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2. Detailed description of the project: methodologies, objectives and results that the project aims to achieve and its interest for the advancement of knowledge, as well as methods of dissemination of the results.
When storms, hurricanes, earthquakes strike, they impact banks’ ability to maintain access to financial services and their lending capacity. Just think about what happened when Hurricane Katrina (2005), Irma (2017), Florence (2018) hit the United States: ATMs and branches were flooded with the impossibility of making ATM withdrawals or cashing checks and systems to back up transactions were blocked. The banks in those areas found themselves suspending the more normal and more basic operations!

Therefore, assessing financial system exposures requires data on physical risk drivers and granular information on the geographical characteristics of financial institutions’ exposures (ECB, 2021). Inversely, transmission risks are mainly measured using the carbon footprint since corporations are under strong pressure (from investors, politicians, and many other stakeholders) to reduce their Greenhouse Gas (GHG) emissions (Climate Action 100+, 2019) mainly driven by carbon emissions. GHG (or carbon) footprint refers to the amount of GHG (or carbon) emissions produced by a good, a service or, in general, a firm’s activity (Bernardini, 2021; Semienluk et al., 2021; De Haas and Popov, 2019; Harangozo and Szigeti, 2017).

ISSUE 1: The previous discussion presents some challenging research issues: exposure granularity, data availability, sector classification given climate-change policies, firm resilience to CO2 emission, mapping of exposure to physical and transition risk drivers (ECB, 2021).

Another important aspect to consider is how climate-related risk drivers can be transmitted to bank risks (ECB, 2020). To this aim, there are four broad categories of financial risk or sources of risk exposure to managing, namely credit, operational, liquidity, and market risks, that represent a priority for bank risk management (Al-Humas and Al-Ajmi, 2017).

Moreover, there are micro- (such as indirect effects on banks’ individual counterparties and direct effects on banks from impacts on their operations) and macro-economic (how climate risk drivers affect macroeconomic factors and how they impact banks and their effects on risk-free interest rates, inflation, commodities, and foreign exchange rates) transmission channels of climate risk drivers to bank risks.

Furthermore, as reported by ECB (2020), climate-related risk may affect directly or indirectly the probability of default (PD) and loss given default (LGD) of exposures within sectors or geographic areas (credit risk). Furthermore, bank operations may be disrupted by physical damages due to extreme weather events (operational risk).

Therefore, the two banking risks we are interested in are credit and the operational risks (Fig. 1). They have different natures, causes, and consequences for the banking sector (Fig. 2) reflected in the related scientific literature and official reports (EBA, ECB, etc.). Indeed, while the impact of climate-related risks on banks’ credit risk is more consolidated (Capasso et al., 2020; Oguntuase, 2020), although recent and still requires important improvement, the effects on bank operation risk are almost unexplored (ECB, 2021b).

FIG. 2: CREDIT VS OPERATIONAL RISK

A. CREDIT RISK (Fig. 3)
Credit risk is linked to a banking system financing a company within the indirect circuit (i.e., loans) and occurs when borrowers/counterparties fail to meet contractual obligations. Banks cannot be fully protected from credit risk due to their business model, however they can lower their exposure in several ways (diversification, etc.). The risk’s magnitude depends on the default risk of the financed party and is reflected in its PD and LGD (EBA, 2021).

Climate risks, as a result, create economic impacts for the financed party and are directly linked to default risk. In this regard, the environmental performance of firms affects the banks’ lending decisions and collateral requirements (Zhang, 2021).

ISSUE A1: It is necessary, even today, to make a mapping of climate-related risks, according to specific granularities, and to investigate their impacts, since exposure impacts on the default risk of firms and, consequently, the banks’ risk exposure.

OBJ A1: MAPPING THE CREDIT RISK, IN THE FORM OF PHYSICAL AND TRANSITION RISKS, FOR THE BANK DUE TO EXPOSURE TO THE CLIMATE RISK OF POTENTIAL FINANCEABLE COMPANIES.

This goal will be achieved through undertaking a literature review together with a banking data integration (leveraging from
Anacredit, SHS securities holdings statistics, Supervisory reporting data, SDW - statistical data warehouse and BSI - Balance Sheet Items) at different granularities. Some analysts working at the Bank of Italy (BI) and the European Central Bank (ECB) will be personally involved in the construction of the database focused on the measurement of EU and Italian firms’ exposure to physical and transition risks. In addition, an express of interest has been made by Dr. Stéphanie Ramolivaz, Supervision Analysts in Single Supervisory Mechanism (SSM), currently working on the Thematic reviews of climate and environmental risk (TR CEER) and Climate risk stress test. These stakeholders will play an important role in defining the variables of interest and the database design. Preliminary statistical analyses, time-space econometric models and data mining techniques will be employed to measure physical and transition risk exposure, at different granularities. OBJ A1 outcome will be an ECB Working Paper (wp) containing the methodological literature review on transition risk, jointly written with ECB colleagues; a map of climate-related risk; and a comprehensive dataset.

The impact of a firm’s carbon footprint affects all the GHG emission levels defined by the GHG Protocol, namely the direct emissions from owned or controlled sources (Scope I), the indirect emissions from purchased electricity, steam, heating, and cooling consumed by the corporation (Scope II), together with all the other indirect emissions occurring in a company’s value chain (Scope III). Therefore, corporate carbon footprints are relevant to the entire energy value chain (Climate Action 100+, 2019; Nguyen et al., 2021).

Corporate GHG footprints are mainly dominated by carbon emissions from energy use that justify the use of a corporate carbon footprint as a proxy for GHG footprint (Nguyen et al., 2021) and for climate-related transition risks (Alam et al., 2019; Ilhan et al., 2021). In fact, corporate carbon footprints should represent the firm’s contribution to the global warming process, namely increased costs and/or reduced sales potentially induced by the decarbonization of the global economy. Nevertheless, this measure appears to be insufficient, especially with a forward-looking perspective, to fully capture the complexity of “multiple drivers and transmission channels, as well as the importance of assessing the decarbonization trajectory and the potential for technological innovation” (ECB, 2021). In this regard, pollution, waste, and water (OECD, 2021; Hock et al., 2020) represent important elements to be measured to integrate actual ESG measurements.

ISSUE A2: There is an increasing need to enrich the measurement of transition risks based on carbon footprints to include pollution, waste, and water, to identify a firms’ resilience score and its impact on bank credit risk.

OBJ A2: IDENTIFICATION OF THE EXPOSURE TO (CLIMATE-RELATED) TRANSITION RISKS OF THE FINANCED SUBJECTS, THROUGH THE PROPOSAL OF A NOVEL AND MORE EXHAUSTIVE INDICATOR THAT CONTEMPLATES NOT ONLY GHG EMISSIONS BUT ALSO THE IDEA THAT THE COMPANY’S DELAY TOWARDS TRANSITION MAY BE DUE TO NEGATIVE IMPACTS IN TERMS OF POLLUTION, WASTE AND WATER, AS WELL TO TECHNOLOGICAL ADAPTATION DELAYS.

A2.1 This analysis will be conducted at the national and European levels. Time series by country and NACE sectors will be collected concerning carbon emissions, pollution, waste and water (rains and water reserves). We will first investigate the different steady states reached by the EU countries/sectors with a long-run perspective via club-convergence analysis (Phillips and Sul, 2007; 2009). This methodology, allowing for different transitional paths as well as heterogeneity, will enhance the progress of countries/sectors in emission reduction and harmonization in a context still characterized by different regulatory frameworks and levels of technology adoption (Cassetti et al., 2021; 2022). These results will be compared with the mapping of national/international policies, to suitably measure the delay (via, for instance, state sequence analysis techniques, suitable quantitative and qualitative metrics) and best practices with respect to the EU goals. Empirical evidence will be presented: i) in at least one quantitative paper submitted to peer review journals; ii) in two conference proceedings (one on emissions, the other on the methodological contribution); and iii) with stakeholders (policy makers, firms, etc.) in a round table involving firms, banks and central authorities.

A2.2 Available data will be enriched by data, collected at a sector and/or firm level, based on a jointly designed survey with the Camera di Commercio and Confindustria to obtain more granular information, also useful for a better understanding of the Italian sectors/regions which will need ad hoc interventions to meet the environmental EU’ goals (Paris Agreement, 2015). There will be meetings with stakeholders to define a joint final version of the survey, given that it also represents an opportunity to convey firm climate change related messages, needs, and critical areas for the economic, and especially, financial systems. Data collected in this survey will be of crucial importance also for policy makers. At the end of the collection process, after preliminary statistical descriptions of the main results, a round table will be organized to disseminate the main results to policy makers, associations, firms, and students.

A2.3 Steps A2.1 and A2.2 will allow to build a more comprehensive and dynamically adjusted indicator of transition risk. We aim to construct a firms’ resilience score to transition risks for specific geographic or industrial contexts. This objective will also be attained by collaborating with the BI and ECB, which would allow us to gain important insights on measuring the transition risk. The resilience score to transition risk will be a (quantitative/qualitative) indicator that contemplates the possibility of dynamic adjustments according to the change in transition policies towards a green economy. Comparison with other tools to measure transition risk will be performed, and a methodological paper will be produced. Results will also be shared with ECB, BKI, Confindustria, and Camera di Commercio during dedicated workshops and/or round tables.

A2.4 The resilience score impacts on the company’s economic fundamentals (i.e., the company’s robustness such as operating costs, EBIT, cash flow from AIDA and AMADEUS, and/or collected through the survey) will be investigated, also considering time lag effects. This analysis will be enriched by national/international case histories (based on interviews) of selected firms that have already
started a transition process, have only modified some production/procurement choices, or are behind in their transition. Best practices and the effects of the transition risk (via the novel resilience score) on firms’ economic/competitive condition will be studied and reported in a wp. Moreover, we will discuss how resilience scores help identify greenwashing. Step A2.4 requires a more direct involvement of some firms, selected among the most relevant sectors for this project, as for instance the electricity one (ECB, 2020; 2021), for in-depth interviews.

ISSUE A3: understanding how to integrate the influence of geopolitical risk on climate-related risks (Alsagr and van Hemmen S., 2021) with the resilience score of bank borrowers, to have a more exhaustive representation of banks’ exposure to credit risk.

OBJ A3: EVALUATE HOW FIRM RESILIENCE SCORES AND GEOPOLITICAL RISKS AFFECT BANKS’ CREDIT RISK

We devote our attention to the banking sector and its activity in terms of generating loans and monitoring. In this context, the credit risk to which banks are exposed is impacted by climate-related risks through higher default risk for borrowers (corporates, households), as PD and LGD are negatively affected, and through possible collateral depreciation/lower collateral valuation. Obviously, this may lead to losses for banking institutions as climate-related risk drivers act through the bank’s counterparties. In this regard, we are interested in the estimation of the effect of climate-related (physical and transition) risk drivers, by also using a resilience score. Methodologically, we predict PD and LGD also considering the resilience score and employing Bayesian econometric models (Porcu et al., 2012) which will help to update them, also by attributing a non-zero probability to potential events not yet occurred or with an increasing future occurrence frequency. To this aim, the effects of geopolitical risks on climate risks will also be investigated using time-space econometrics (Porcu et al., 2012) and helping banks with a parsimonious variable selection based on machine learning (Uematsu and Tanaka, 2019) and variables mutual information. This allows (central) banks to reduce the burden of data collection for PD/LGD predictions, while still preserving their accuracy.

The results will be discussed with stakeholders during round tables and workshops and a quantitative paper will be produced.

B. OPERATIONAL RISK (Fig. 4)

This part of the project is focused on a banks’ own, i.e. direct, exposure (and not that of their counterparties such as, for example, non-financial corporations) to operational risks induced by climate-related risks that take the form of physical risks. In the regulatory framework of the banking sector, operational risk is defined by the Basel Committee on Banking Supervision (BCBS, 2003, 2006, 2011, 2021c) as the risk of loss resulting from inadequate or failed internal processes, people, and systems or from external events. Supervisory authorities specify requirements for banks about the operational risk: under Pillar I, a banks’ exposure to operational risk contributes to the generation of capital requirement, but its treatment is also foreseen under Pillar II and it is involved in the disclosure requirements set by the DCDS under Pillar III.

Among the components/sources of operational risk, mentioning “external events” (exogenous events) legitimizes the inclusion of climate-related risks in the form of physical risks as sources of operational risks. Physical hazards/risks from climate change can affect banks in terms of adverse impacts for business continuity through the generation of business interruptions, system failures, damages to a bank’s infrastructure, assets/properties, branches/offices, data centers and in relation to outsourced functions. There are economic impacts associated with these operational risk events arising from physical risks: the undisputed ones are revenue losses and repair costs. A few examples that are widely known of severe events, caused by physical risks, that resulted in large losses for the banking sector are: the hurricane Katrina in the US in 2005, the Tohoku earthquake, and tsunami in Japan in 2011.
(Hosono et al., 2016). Nonetheless, BCBS (2021a) observed that “Physical hazards can affect banks directly as operational risks. There is little public research on the operational risks faced by banks and arising from physical risk drivers”. Furthermore, some surveys revealed a lack of awareness of the significance of the possible consequences of climate-related risks for the banking sector also in terms of operational risks. For example, in the survey conducted by the Austrian Environment Agency, less than one-third of respondents were aware that operational risks were affected by climate change (FSR by Oesterreichische Nationalbank, 2019). In its reports, “The state of climate and environmental risk management in the banking sector” (November 2021b), the ECB noted that, while considerable steps have been taken, most institutions are still at an early stage of integrating climate and environmental risks into their operational risk management.

Central Banks and supervisory authorities have now developed the conviction that climate-related risks are crucial risk determinants for the banking sector and have formulated expectations/requests for progress and refinements precisely, in operational risk management. The ECB in “Guide on climate-related and environmental risks” (November 2020) states that “Institutions are expected to assess the impact of physical risks on their operations in general, including the ability to quickly recover their capacity to continue providing services. Institutions are reminded that this assessment should be conducted as part of their business continuity management, as set out in the EBA Guidelines on internal governance”. The BCBS (2021b) stipulates that “Banks should understand the impact of climate-related risk drivers on their operational risk and ensure that risk management systems and processes consider material climate-related risks. Banks should also understand the impact of climate-related risk drivers on other risks and put in place adequate measures to account for these risks where material”.

ISSUE B1: Both the research of the scientific community and the attention of practitioners are still at an early stage of integrating climate and environmental risks into banks’ operational risk management. This creates a misalignment with the supervisory authorities’ expectation and therefore steps forward must be taken.

Operational risk has a distinctive feature compared to other banks risks like market risk or credit risk: it is not taken on a voluntary basis, and it can only generate losses and vulnerabilities for the bank. At the same time, physical risks deriving from climate change have unique features: spatially varying characteristics of their impacts, exposure to high uncertainty in terms of reliability of historical information, heterogeneity in their severity and frequency.

To effectively manage climate-related operational risks arising from climate physical risks to protect the business continuity and the banks’ safety and soundness, emphasis must be placed at bank level on an accurate and predictive understanding of the occurrence of physical risks and the mapping/identification of bank’s exposures to physical risks as a necessary prerequisite for the subsequent assessment of possible operational risks.

We intend to make significant progress in the direction of an accurate and granular understanding of a bank’s potential exposure to physical risks. To build a forward-looking approach, that is, an analysis that captures the prospective/potential exposure to physical risks, we propose to introduce and investigate the use of more recent techniques in Time-Space modelling (Porcu et al., 2012). Indeed, thinking about how physical risks are described, it is correct to say that they determine “events” that tend to exhibit both a spatial and a temporal dependence.

ISSUE B2: There is a lack, principally from a methodological point of view, in the forward-looking mapping of physical risk drivers that can generate a bank’s exposures to operational risks.

OBJ B1: ESTIMATING BANK’S POTENTIAL DIRECT EXPOSURE TO CLIMATE-RELATED RISKS IN THE FORM OF PHYSICAL RISKS AS A POSSIBLE SOURCE OF OPERATIONAL RISK, INVESTIGATING THE USE OF TIME SPACE MODELLING.

To pursue the goal of mapping physical risk drivers, we will collect data from sources like NASA resources, Refinitiv, EM-DAT, Climate Change World Bank data. Moreover, methodologically, the involvement of consultants will be crucial for selecting the most suitable model to apply for forecasting the risk drivers. The expected outcome is a scientific paper.

For a correct understanding of the bank’s exposure to physical risks (both acute and chronic) deriving from climate change, we also believe that the possible inclusion of exposure to geopolitical risks, as a possible source of operational risks, deserves to be investigated. The logical premise is the awareness that climate change can exacerbate the vulnerabilities of certain countries/regions with the effect of intensifying geopolitical tensions (emergence of conflicts, insecurity, worsening of health conditions) as recognized by La Shier and Stanish (2019) and the World Bank (2011).

ISSUE B3: Preliminary scientific research has recognized that climate change is a driver of geopolitical tensions. However, in the banking sector there is a lack of awareness of this link and, consequently, of theoretical and empirical investigation in this field.

OBJ B2: UNDERSTANDING THE DEGREE OF BANK’S PERCEPTION OF EXPOSURE TO GEOPOLITICAL RISKS INTENSIFIED BY CLIMATE CHANGE AS A SOURCE OF OPERATIONAL RISK.

In this regard, we intend to verify whether banking institutions have developed the correct perception of geopolitical risks as a possible consequence of climate change. And if so, if these risks are interpreted as contemporary or delayed effects with respect to the occurrence of climate-related risks. From a methodological point of view, we intend to proceed with a few in-depth interviews with the managers responsible for Business Continuity & Resilience and the Compliance unit of some significant banks in the EU. In addition, we will study possible contemporaneous or lagged connections between climate-related risks and the behavior of the GPR
(the geopolitical risk index) using space and time-space modelling. The results will be disseminated during a round table with the interviewed managers, sectorial operators, and authorities. Moreover, the empirical study of the interconnection between climate-related risks and the behavior of the GPR will be presented in at least one wp (Vita&Pensiero, department wp, and/or EBC wp).

The assessment of the bank’s direct exposure to physical risks also requires an in-depth knowledge and identification of the geo-spatial characteristics of the financial institution, since the geographic locations of where the bank “operates” might make it more prone to physical risks. Through the preliminary delivery of a survey of some significant banks (those under the ECB’s direct supervision) and the subsequent direct discussions of the results obtained with the involved banks, we aim to advance existing methodology on the mapping of a bank’s exposure to physical risks, which can be helpful for the banking sector.

OBJ B3: TO PROVIDE A BETTER FOUNDATION TO A BANK’S MAPPING EFFORT, WE WILL ELABORATE GUIDELINES FOR A GRANULAR EXPOSURE ANALYSIS OF PHYSICAL RISKS THAT CAN GENERATE OPERATIONAL RISKS FOR THE FINANCIAL INSTITUTION, TAKING INTO ACCOUNT THE BANKS’ DIFFERENT BUSINESS LINES AND OPERATIONS, LOCATIONS OF BANK’S SUBSIDIARIES AND THEIR ACTIVITIES, AND LOCATION OF SERVICES PROVIDERS FOR OUTSOURCED SERVICES.

The choice of significant banks for the survey is well motivated: they are most likely to be involved in diversified activities and to operate across-borders. On this point, it should be remembered that Chernobay et al. (2021) state that the magnitude and the frequency of operational risk events increase significantly with bank complexity. The results will be disseminated with appropriate guidelines and during a round table with the interviewed managers, sectorial operators, and authorities. Moreover, a working paper will be presented (Vita&Pensiero, department wp, and/or EBC wp).

Coherence with the PNRR: From the presented project details, even if a strong coherence with Mission 2 (Green revolution and ecological transition) and 4 (Instruction and research) of the PNRR emerges. However, here we propose a different point of view that positions our contribution in a complementary way with respect to the NRRP missions.

3. Project development, with identification of the role of each research unit, with regards to related modalities of integration and collaboration

The 4 units involved in the project are characterized by the heterogeneity of their scientific disciplines. Nevertheless, the UniTO and UniCATT research units (RUs) are more quantitative (econometrics and political economy) while UniVDA and UniCH have competences in financial intermediaries and economic policy.

The project is intended to last 24 months, and is articulated in 7 Work Packages (WP) aimed at addressing the topics and objectives discussed in Section B1.2, as well as at ensuring effective coordination and dissemination of the findings (see Fig. 5). A RU will be selected to coordinate each WP within different tasks have been identified. Each task is developed by one or more RU, and the detailed description of the role of each RU is provided in every WP.
FIG.5: WORK PACKAGES (WP)

WP1: Literature review and data (Leader: UniTO, other partners: UniVDA, UniCATT, UniCH)
WP1 is meant to provide the building blocks of the projects. WP1 addresses objective OBJ A1 and part of OBJ B1, and is articulated in 3 tasks:
Task 1.1: Coordinated efforts with the aim of i) providing a systematic literature review on climate-related risk measurements, banks’ credit risks and banks’ operational risks; and ii) articulating a conceptual research framework as reference for the subsequent analyses.
Task 1.2: Exploration of the existing data sources (geospatial) to compile an exhaustive project database, fundamental for the empirical investigations that will be carried out in WP2, WP3, and WP4. In particular, Task 1.2 data on physical and transition risk drivers will be collected at different granularities.
Task 1.3: Exploration of the existing data sources on the exposure of banks and firms to compile an exhaustive database, fundamental for the empirical investigations that will be carried out in WP2, WP3, and WP4. In Task 1. data on firms by country/NACE sector as well as on national and international banks will be collected.

WP2: Climate-related risks (Leader: UniCATT, other partners: UniTG, UniCH)
WP2 articulates an analysis (also with the support of interactive maps) of the main climate-related risks which could influence bank risk management. WP2 addresses part of the objective OBJ A2 and the remaining part of OBJ B1; it is articulated in 3 tasks:
Task 2.1: Mapping of Italian and European physical risk drivers considering both acute and chronic risk forms also with a forward-looking perspective.
Task 2.2: Mapping of Italian and European transition risk (particular attention will be dedicated also to pollution, waste and water).
Task 2.3: Mapping of geopolitical risks to allow the measurement of their impacts on climate change and vice versa.
The WP2 mapping will be the basis of the quantitative analysis that will be carried out in WP3, and WP4.

WP3: Bank credit risks (Leader: UniCH, other partners: UniTO, UniCATT)
WP3 aims to introduce a novel resilience score for the measurement of the transition risk driver. Moreover, it will investigate banks’ exposure to credit risk via the mediating role of borrowers which could be exposed to climate-related risk drivers. Therefore, WP3 addresses objective OBJ A2 and OBJ A3, and it is articulated in 5 tasks:
Task 3.1: Club-convergence analysis of firms’ emissions, pollution, waste, and water, at regional levels and by NACE sectors, compared to a mapping of the policies and environmental goals. This will allow to highlight best practices as well as delays (OBJ A2.1)
Task 3.2: Elaboration of an ad hoc survey -designed jointly with stakeholders - for data collection of firms’ granular information not yet systematically collected over technological adaption and emission reduction choices to achieve environmental EU goals (OBJ A2.2)
Task 3.3: Elaboration of a more comprehensive and dynamically adjusted indicator of transition risk (OBJ A2.3)
Task 3.4: Analysis of the resilience score impacts on companies’ economic fundamentals (OBJ A2.4)
Task 3.5: Measure of the impact of borrowers’ resilience score and geopolitical risks on banks’ credit risk (OBJ A3)
The quantitative analysis conducted in WP3 will be at the basis of WP5 and WP7.

WP4: Bank operational risks (Leader: UniVDA, other partners: UniTO, UniCATT)
WP4 investigates and measures bank operational risks with particular attention to how physical risk (both acute and chronic) affects it. WP4 addresses objective OBJ B2 and OBJ B3, and it is articulated in 4 tasks:
Task 4.1: a few in-depth interviews with significant bank manager on their perception of exposure to operational risks (OBJ B2)
Task 4.2: measurement of how climate related risks could be drivers of geopolitical risk considering the geopolitical risk index (OBJ B2)
Task 4.3: methodological advances on the bank exposure mapping of operational risk due to physical risks, given the two previous tasks (OBJ B3)
Task 4.4: elaboration of bank guidelines on operational risk management (OBJ B3)

The outcomes of WP3 will be at the basis of WP5 and WP7.

WP5: “Lessons” for banks and stakeholders (Leader: UniVDA, other partners: UniTO, UniCATT, UniICH)
WP5 is deputed to the collection of the main project results from WP2, WP3, and WP4 of explicit interest to banks and involved stakeholders. The results will be organized systematically, describing connections and complementarities amongst credit and operational risk models, physical and transition risk maps, risk guidelines, and banks’/firms’ risk perceptions. Different area of intervention for policy makers will be also identified, and possible remedial policies will be proposed.

WP6: Management and coordination (Leader: UniTO)
WP6 is dedicated to the management and coordination of the project by the lead RU (UniTO). WP6 will ensure the smooth operation of the activities envisaged by the project from the formal, financial, and administrative perspective. Bimonthly (online and/or in presence) meetings with the other RUs, communications, and progress monitoring are expected.

WP7: Dissemination (Leader: UniTO, other partners: UniVDA, UniCATT, UniICH)
Finally, WP7 collects all the dissemination activities. Two workshops will be organized, online and/or in presence, at UniCH and UniVDA. Two round tables will be organized, online and/or in presence, at UniCATT and UniTO. The UniCATT one will be dedicated mainly to bank managers, banking authorities, and practitioners. The UniTO one will mainly involve local stakeholders (such as Camera di Commercio, Confindustria). A series of 6 (online and/or in presence) seminars will be organized at UniTO for scholars and practitioners.

Outcomes of the project will be also presented at national and/or international scientific conferences and workshops. The papers will be submitted to international peer reviewed journals (see section 4) with a high ranking, also preliminary results will be submitted to wp series with ISBN codes (ECB wp, UniTo wp, Vita&B Pensiero,...). In any case, scientific research outcomes will be made available in preprint in ArXiv.

Specific attention will be given to stakeholder involvement at many steps of the project, via formal and informal meetings and dissemination events (sec. B1.4).

**PROJECT SCHEDULE (FIG. 6)**

**FIG.6: PROJECT SCHEDULE**

<table>
<thead>
<tr>
<th>WP</th>
<th>1st YEAR</th>
<th>2nd YEAR</th>
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<td>WP1: LITERATURE REVIEW AND DATA</td>
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<td>Q3 (7-9)</td>
<td>Q1 (13-15)</td>
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<td>TASK 1.3</td>
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<tr>
<td>WP2: CLIMATE-RELATED RISKS</td>
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<td>TASK 2.1</td>
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<td>TASK 2.2</td>
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<td>TASK 2.3</td>
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<tr>
<td>WP3: BANK CREDIT RISKS</td>
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<td>TASK 3.1</td>
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<td>TASK 3.5</td>
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<td>WP4: BANK OPERATIONAL RISKS</td>
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<td>TASK 4.1</td>
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<td>TASK 4.4</td>
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<tr>
<td>WP5 - LESSONS FOR BANKS AND STAKEHOLDERS</td>
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<td>WP6 - MANAGEMENT AND COORDINATION</td>
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<td>WP7 - DISSEMINATION</td>
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**MODALITY OF INTEGRATION AND COOPERATION**
The 4 units will be involved in an internal online team building meeting every two months (for a total of 12), 4 of which will be in person (in turn in one of the 4 RU). There will be an extensive collaboration across units - mediated and facilitated by the PI of the project - also in terms of co-authorships of publications. The project gathers scholars with different competences, providing added value to the project. Therefore, most of the tasks will be carried out by scholars from different RUs, in order to exploit their complementary knowledge. Finally, it is worth noting that especially UniTO, UniCATT and UniVDA have already recently had
experience joint research collaborations. Thus, the project can build on previously established cooperation, ensuring the successful management and development of the activities.

OPPORTUNITIES FOR YOUNG RESEARCHERS

Most of the project budget will be devoted to hire 3 early career researchers (with annual research grants). Additionally, the staff of the 4 RUs will involve young researchers and post-docs. Moreover, important training opportunities (for all the members of staff) will be organized in relevant research centers such as Khalifa University (Abu Dhabi) for time-space modeling; limas-UNam (Mexico City) for Bayesian nonparametric statistics; the Hebrew University Center for Climate (Jerusalem); and BIAS Business-City and/or Imperial College (London) for financial sustainability, as well as European Central Bank (Francoperta/Germany). This speaks for project partners’ commitment to the training of new researchers on the topics and methodologies of this proposal. Finally, we will need consulting services for the selection and implementation of the most suitable time-space model for climate-related risk prediction, both for bank credit and operational risks (given the high technicalities required).

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4. Possible application potentialities and scientific and/or technological and/or social and/or economic impact

The project will disseminate the research results through a series of specific outputs aimed at reaching different targets.

ARTICLES IN ACADEMIC JOURNALS, WORKING PAPERS & PROCEEDINGS

1. At least 4 scientific papers
   a. At least 1 paper to illustrate the results of a club-convergence analysis comparing different time series of carbon emissions, pollution, waste and water with the local and EU environmental Goals (OBJ A2);
   b. At least 1 methodological/quantitative paper concerning the construction of the resilience score and its impacts on the firms’ economic drivers (OBJ A2);
   c. At least 1 quantitative paper on the time-space modelling of the climate-related risks as a key factor to predicting bank credit risk (OBJ A3);
   d. At least 1 quantitative paper on time-space modelling of the climate-related physical risks for measuring bank operational risks (OBJ B1).

2. At least 4 working papers (wp) on, for instance:
   a. methodological literature review on the measurement of physical and transition risks (Vita&Bensiero, Department wp/ECB wp) (OBJ A1);
   b. best practices of firms on technological/production process adaptation to reduce GHG emissions (Vita&Bensiero, Department wp/ECB wp) (OBJ A2);
   c. bank perception of exposure to operational risks due to climate-related risk drivers (Vita&Bensiero, Department wp/ECB wp) (OBJ B2);
   d. guidelines for operational risks of banks and/or best practices undertaken by relevant national/international banks to manage operational risks (Department wp/ECB wp) (OBJ B3).

3. At least 2 conference proceedings:
   a. methodological (SIS, GRASPA) with preliminary results of the resilience indicator and/or the mapping of emissions and/or the time-space modelling of physical risk (OBJ A2/OBJ A3/OBJ B1);
   b. empirical (AIEE) based on club-convergence analysis (OBJ A2).

According to the project research objectives and methodologies, a set of coherent peer reviewed journals with a high national evaluation (ANVUR class A) and a high impact factor are identified as possible destination for the previously mentioned articles. Journals ranked as A by the Italian ANVUR ranking system for all the 13 area:
- European Financial Management; Corporate Social Responsibility & Environmental Management; Journal of Economic Behavior & Organization (Art 1a, Art 1c)
- Journal of Banking and Finance; Quantitative Finance (Art 1c)
- Energy Policy; Energy Economics; Journal of Cleaner Production (Art 1a)
- Environment and Planning A; Environmental Science & Policy (Art 1b)
- Environmental Innovation and Societal Transitions; Economics of Innovation and New Technology; Eurasian Business Review (Art 1b)

Journals ranked A but not for all the 13 area:
- Journal of Economic Asymmetries; Global Business Review; Journal of Environmental Management (Art 1b);
- Spatial Economic Analysis; Spatial Statistics (Art 1b, Art 1d).

At least one scientific article, published in a peer reviewed journal will be in Open Access. To allow the preliminary dissemination of the results, all the papers will be published on free preprint platforms, such as ArXiv.

WORKSHOPS AND ROUND TABLES

The 4 units will organize (in person and/or online) 2 workshops (one organized by the UniYDA RU, one by the UniCH RU) and 2 round tables with the main stakeholders (one organized by the UniTO RU, one by the UniCATT RU), with possibly national/international scholars/experts as guests. A series of 6 seminars (in person and/or online) will be also organized by the UniTO RU on project topics.
OPEN-SCIENCE PLATFORM.
The 4 units will cooperate in creating i) databases via surveys, data collection and interviews, and ii) European/Italian interactive maps. Indeed, in an open-science platform we will allow to visualize a:
1) dynamic map of climate-related physical and transition risks; 2) dynamic map representing the club-convergence analysis according to emissions related to transition risk (carbon footprints, waste, water, pollution); 3) dynamic map of the novel resilience score. Sharable/anonymized data, maps and R codes resulting from this project will be made freely available to scholars, banks and experts under CC license, to guarantee reproducibility of the research, as well as further extensions and explorations.

EXPECTED ACADEMIC IMPACTS.
Scientific contributions and maps will provide additional and powerful tools to the economic and financial community to measure climate-related risks and their impacts to better manage banks’ risks as well as to answer general questions concerning the most recent and urgent issues brought about by climate change. This is of particular interest also the focus on geopolitical risks and their reciprocal “contamination” with climate change.
Moreover, dynamic maps will remedy the lack of granular data and the burden of a vast data collection that impedes, in many banks and economic sectors, the opportunity of robust risk evaluation and management of climate-related risks and their impact.
The project could also have a methodological impact, with important developments in econometrics and in space-time modelling. This research framework represents an interesting test bed for the integration of different types of machine learning, econometrics and statistics techniques to improve the predictability and estimation power of more traditional approaches.
UniVDA and UniCH RU will organize, respectively, a scientific workshop (in person and/or online) to disseminate the project results, interact with scholars in financial sustainable and environmental fields, and take advantage of guest speakers’ lectures (e.g. from Khalifa University, limas-Unam, etc.). The UniTO RU will organize a series of 6 seminars (in person and/or online) on the project’s fields of research not only to disseminate within the national scientific community the project results, but also to deepen some topics of interest. Within these seminars at least one will be held by a speaker from ECB. Finally, thanks to partaking in national/international conferences, the results of this project could be used:
• International Conference on Computational and Financial Econometrics (ERCIM - CFE); Annual SoFiE (Society in Financial Econometrics) conference;
• Scientific Meeting of the Italian Statistical Society; ISBA World Meetings; International Workshop in Spatial Econometrics And Statistics;
• GRASPA (Gruppo di Ricerca per le Applicazioni della Statistica ai Problemi Ambientali) biannual conference;
• Positive Investment Symposium, Imperial College Business School; Global research alliance for sustainable finance and investment, Annual conference; Annual meeting European Finance Association; Annual meeting of European Financial Management Association;
• AIEE Energy Symposium; S&P Workshops.

EXPECTED ECONOMIC IMPACTS
The project will develop important economic impacts from different perspectives. In particular, we emphasize the: i) identification of the areas characterized by higher climate-related risks; ii) development of bank guidelines for the reduction of the credit and operational risks due to physical and transition risk drivers; iii) practical contributions to the risk management of banks and firms; iv) identification of best practices; v) increase awareness within the banking sector, and not only, of sources and impacts of climate-change related risks; vi) reduction of data collection burden for banks; vii) support to the banking institutions to align with supervisory authorities’ expectations on operational and credit risk management, including climate-related risks; viii) a significant and complementary contribution to NAPD missions (2 and 4); ix) positive impacts on stakeholders, and the overall community.
Moreover, our findings could be directly used by policy makers to address specific intervention measures, as well as by banks to adjust risk management strategies by rightly including appropriate measurements of climate-relate risks and, therefore, acting to reduce bank risk exposure.

EXPECTED IMPACT ON TEACHING AND LEARNING.
Research, datasets and maps here made available can represent a preliminary step toward developing open, innovative online teaching and learning tools and resources. The 4 units could cooperate in preparing draft guidelines about the possible creation of a platform providing a navigable map of climate-related risks that could be used in lectures and laboratories of the national/international degree courses. This will also enforce universities’ positioning with respect to events such as “Friday for Future” (see e.g. UniTO). Moreover, they will help (current and future) bank managers to acquire a deeper knowledge and awareness of the most critical aspects linked to climate-related risks. This topic will be potentially discussed at finance and financial econometrics courses at universities of the 4 RU.
From an educational perspective, the content of this project can also motivate, support, and stimulate critical reasoning of learners. This could be also reinforced by opening the seminar series to students (to varying degree), banks, practitioners and, more in general, stakeholders. Finally, there will be specific training and formative events for stakeholders (such as ECD, OKI, Camera di Commercio, Confindustria).

5. Financial aspects: costs and funding for each research unit
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<th>nº</th>
<th>Name</th>
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<th>MUR funding (other items) (euro)</th>
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N.B. The fields will be filled in automatically

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Semieniuk G et al. (2021) Low-carbon transition risks for finance. Wiley Interdisciplinary Reviews: Climate Change, 12(1), e678
Zhang D (2021) How environmental performance affects firms’ access to credit: Evidence from EU countries, J Clean Prod 315

B.2

1. Scientific Curriculum of the Principal Investigator

2. Scientific Curriculum of the associated investigators

1. FEDER Christophe
SCIENTIFIC CURRICULUM
Christophe Feder, PhD
CURRENT POSITIONS
From February 2022: Researcher at the Università della Valle d’Aosta/Università de la Valle d’Aoste
OTHER AFFILIATIONS
From February 2018: Affiliation of the BRICK (Università degli Studi di Torino)
From July 2017: Affiliation of the CT TEM (Università della Valle d’Aosta/Università de la Valle d’Aoste)
PAST POSITIONS
From November 2020 to November 2021: Research fellow at the Università della Valle d’Aosta/Università de la Valle d’Aoste
From September 2019 to September 2020: Research fellow at the Università della Valle d’Aosta/Università de la Valle d’Aoste
From December 2015 to December 2016: Research fellow at the Università della Valle d’Aosta/Università de la Valle d’Aoste
EDUCATION
June 2017: Summer school in Marketing and economics of tourism at the Università della Valle d’Aosta/Università de la Valle d’Aoste
From January 2013 to November 2015: PhD in Economics & Complexity at the Università degli Studi di Torino and Collegio Carlo Alberto
From November 2014 to March 2015: Visiting at the University of California: Irvine
May 2014: Summer school in Competition and Innovation at the Centre for European Economic Research (ZEW)
July 2013: Summer school in Knowledge Dynamics, Industry Evolution, Economic Development at the Université Nice Sophia Antipolis
From September 2011 to September 2012: M.A. in ECOMATH (Economie mathématique et économétrie) at the Toulouse School of Economics
From August 2010 to June 2011: M.A. in Economics at the Collegio Carlo Alberto
From September 2008 to March 2011: Advanced undergraduate degree in Economics at the Università degli Studi di Torino
From September 2005 to November 2008: Undergraduate degree in Business Administration at the Università della Valle d’Aosta/Università de la Valle d’Aoste
RESEARCH INTERESTS
Economics of Innovation, New Institutional Economies, Regional Economics.
AWARDS AND GRANTS
National Academic Qualification as Full Professor in Applied Economics.
National Academic Qualification as Associate Professor in Applied Economics.
National Academic Qualification as Associate Professor in Economic Policy.
Awards in the 2nd TEM Conference for the article: “Directed technological change and technological congruence: A
new framework for the smart specialization strategy” with C. Antonelli and F. Quatraro.

CONFERENCE ORGANIZATION
First PhD workshop “Economics of Innovation, Complexity and Knowledge”, Turin, 2013

CONFERENCE PARTICIPATION (RECENT)
[6] “Une enquête sur les guides de la Vallée d’Aoste”, FIMM and FEAST Seminar, Chambery, 2018
[8] “Some economic principles on sharing economy”, FIMM Conference, Chambery, 2018

NATIONAL TEACHING ACTIVITIES (RECENT/SELECTED)
From September 2017 to February 2022: Teaching at the Università della Valle d’Aosta/Université de la Valle d’Aoste
From September 2017 to September 2019: Teaching Assistant at the Università della Valle d’Aosta/Université de la Valle d’Aoste
From September 2015 to September 2017: Teaching Assistant at the Università degli Studi di Torino
From March 2014 to September 2017: Teaching Assistant at the Politecnico di Milano
From April 2013 to July 2013: Teaching at the Università della Valle d’Aosta/Université de la Valle d’Aoste
From September 2013 to December 2013: Teaching at the Università della Valle d’Aosta/Université de la Valle d’Aoste

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4

2. ZOIA Maria
CURRICULUM VITAE

Maria Grazia Zoia, graduated with honors in Political Science at the University of Milan, and in Statistics at the Catholic University, obtained a doctorate in Applied Statistics at the University of Florence: the thesis was awarded the prize of the Italian Society of Statistics.
She is full professor of Econometrics in the Faculty of Economics and she has also been invited professor at the University of Geneva. Her main scientific interests lie mainly in the area of methodological econometrics and are aimed in particular at the tools and techniques of econometric modeling and the quantitative analysis of economic and social phenomena. She is the author of monographs, texts, and numerous essays in international journals, in which methodological contributions are combined with attention to applicative implications.

CURRENT POSITIONS
Full Professor of Econometrics at the Faculty of Economics at the Catholic University in Milan.

PAST POSITIONS
Associate Professor of Econometrics at the Faculty of Economics at the Catholic University in Milan.

OFFICIAL ASSIGNMENTS:
Director of the Laboratory on Research in Business Communication of the Catholic University in Milan.
Member of the Presidium of the Catholic University for the research assessment.

EDUCATION
She graduated with honors in Political Science at the University of Milan and in Statistics at the Catholic University. PhD in Applied Statistics at the University of Florence.

RESEARCH INTERESTS
Her main scientific interests lie mainly in the area of methodological econometrics and are aimed in particular at the tools and techniques of econometric modeling and the quantitative analysis of financial, economic and social phenomena.

AWARDS AND GRANTS
Her PhD thesis was awarded the prize of the Italian Society of Statistics.

CONFERENCE PARTICIPATION
2021 ERFIN workshop (Econometric research in Finance workshop), 2021, SGH Warsaw School of Economics, Poland. Talk: Resorting Portfolio Kurtosis for Risk Parity Allocation
2021 TEM workshop, 2021, Aosta, Italy. Talk: MIDAS regressions to forecast domestic traveler indicators
2020 5th AIEEE Energy Symposium, 2020, Milan, Italy. Talk: How far we are from price convergence in the EU energy markets? A two steps procedure to define a composite index of electricity and natural gas prices

NATIONAL OR INTERNATIONAL RESEARCH PROJECTS (SELECTED)
CNR project: “Stima e previsione del ciclo trend delle serie storiche economiche con metodologie avanzate della teoria dei filtri in un’ottica econometrica” 200-2003.
MURST project 60%: L’analisi delle serie storiche nell’ottica della teoria dei filtri 1997/98.
MURST project 40%: Contributi attuali della metodologia statistica all’econometria.
CNR project Identificazione e stima delle componenti delle serie economiche in un’ottica frequenziale, 1995/96.
CNR project: Analisi qualitativa dei modelli econometrici sotto il profilo della causalità e della interdipendenza 1994/95.
MURST project 60%: Identificazione e stima delle componenti caratteristiche delle serie economiche secondo un approccio integrato nei domini temporali e frequenziali 1993/4.
MURST project 60%: La convalida dei modelli econometrici sotto il profilo della verifica della specificazione, 1991/92.
MURST project 40%: nuovi sviluppi dell’analisi statistica delle serie storiche, 1991/93.

INTERNATIONAL TEACHING ACTIVITIES
Invited Professor of Time Series Econometrics at the Geneva University.
NATIONAL TEACHING ACTIVITIES (RECENT/SELECTED)
Econometrics and Applied Econometrics at the Faculty of Economics at the Catholic University in Milan and Econometrics at the Faculty of Mathematics in Brescia.

MEMBERSHIP
Member of SIE, SIDE and SIS.

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3. ANGELINI Eliana
CURRICULUM VITAE

ELIANA ANGELINI
Place and date of birth: OMISSIS
Nationality: OMISSIS

CURRENT POSITION

• Full Professor in Financial Markets and Institutions, Department of Economic Studies, “G. d’Annunzio” University Chieti-Pescara, since June 2018.

PAST POSITION

• Associate Professor in Financial Markets and Institutions, University “G. d’Annunzio” Chieti-Pescara, 2010 -2018. Follows the suitability at University “Marco Biagi”, Modena e Reggio Emilia, 2010.
• Assistant Professor of Financial Intermediaries, University “G. d’Annunzio” Chieti-Pescara, 2005- 2010.
• Research fellow at University of Macerata, Department of Finance and Economic Sciences, 2000-2002.
• Research and Teaching Assistant at Catholic University of Milan, 1998-2001.

OTHER PROFESSIONAL EXPERIENCES

• Teacher in the training course, as part of the R & A Consuling project, for Branch and Asset manager managers of Marche and Abruzzo, Banca Popolare di Rari, Pescara Office (February 2018).
• Teacher at the Master in “Networking Manager in a Corporate”, University of Teramo, 2007-08.
• Teacher at the Master in “Export in Development Generation Process”, University of Macerata, 2004-05.
• Teacher at the EFPA- Courses for several financial intermediaries, 2003.
• Teacher at the “Master in Banking and Finance for Development” “Giordano dell’Amore” Foundation, Milan, 2002.
• Teacher at the Master in “Internet Banking”, Catholic University of Milan, 2001.
• Teacher at the Qualifying Examination for Financial Promoter, FIBA - CISL of Milan, 2001.
• Collaboration with Prof. G.M. Gandellini in Marketing Consultancy - ISTAO, Reggio Emilia; creation a CD in International Marketing Strategies, 1997.

EDUCATION

• Visiting student in MBA Loyola University of Chicago, School of Business Administration, Department of Finance, 1998.
• Bachelor Degree in Economic Sciences & Banking, grade 110/110 “cum laude”, University of Macerata, 1995.

RESEARCH INTERESTS

(1) FINANCIAL RISK MANAGEMENT: CREDIT AND SYSTEMIC RISK; SPILL-OVER EFFECTS, ESG FACTORS; PERFORMANCE
AND BUSINESS MODEL IN THE BANKING SECTOR.

(2) CDS AND DETERMINANTS OF CREDIT SPREADS

MEMBERSHIP OF EDITORIAL BOARDS AND REFERENCE ACTIVITY
• Guest Editor for the Special Issue “Credit Risk Management” in Open Access Journal Risks (ISSN 2227-9091, indexed Scopus) (2020-2021)
• Associate Editor, in Europe, for the Journal of Economic Asymmetries, Elsevier, ISNN: 1703-4949, since 2020

AWARDS


CONFERENCE PARTECIPATION

NATIONAL TEACHING

3. Main Principal Investigator's scientific publications (Max. 20)

4. Main scientific publications of the associated investigators (Max. 20, for each research unit)

1. FEDER Christophe
2. ZOIA Maria


2. Rubina Nava C., Osti L., Ziola maria (2021). From Quantity to Quality: Capturing Higher Spending Markets through a


19. Faliva, Mario, Zoa, Maria (2002). On a partitioned inversion formula having useful applications in econometrics. ECONOMETRIC THEORY, p. 525-530, ISSN: 0266-4666, doi: 10.1017/s0266466602182120 - Articolo in rivista


3. ANGELINI Eliana


5. Main staff involved (max 10 professors/researchers for each research unit, in addition to the PI or associated investigator), highlighting the time commitment expected

List of the Research Units

Unit 1 - NAVA Consuelo Rubina

Personnel of the research unit

<table>
<thead>
<tr>
<th>n°</th>
<th>Surname Name</th>
<th>Qualification</th>
<th>University/ Research Institution</th>
<th>e-mail address</th>
<th>Months/person expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>NAVA Consuelo</td>
<td>Ricercatore a t.d. - t.pieno (art. 24 c.3-b L. 240/10)</td>
<td>Università degli Studi di TORINO</td>
<td>OMISSIS(manca l’adesione)</td>
<td>8,0</td>
</tr>
</tbody>
</table>
(data fine contratto: 21/12/2023)

2. GIOFRE Maëla
Ricercatore confermato
Università degli Studi di TORINO
OMISSIS (adesione completata il 28/03/2022) 2,0

Possible sub-unit

<table>
<thead>
<tr>
<th>Surname</th>
<th>Name</th>
<th>Qualification</th>
<th>e-mail address</th>
<th>Months/person expected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total cost of the research unit, per single item

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>item A.1</td>
<td>9.167 €</td>
</tr>
<tr>
<td>item A.2.1</td>
<td>24.000 €</td>
</tr>
<tr>
<td>item B</td>
<td>19.900 €</td>
</tr>
<tr>
<td>item C</td>
<td>1.760 €</td>
</tr>
<tr>
<td>item D</td>
<td>10.000 €</td>
</tr>
<tr>
<td>item E</td>
<td>11.500 €</td>
</tr>
<tr>
<td>Total</td>
<td>76.327 €</td>
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</table>

N.B. The Item B and TOTAL columns will be filled in automatically
- item A.1: enhancement of months/person of permanent employees
- item A.2.1: cost of contracts of non-employees, specifically to recruit
- item B: overhead (flat rate equal to 60% of the total personnel cost, A.1+A.2.1, for each research unit)
- item C: cost of equipment, tools and software products
- item D: cost of consulting and similar services
- item E: other operating costs

Major new contracts for staff specifically to recruit

<table>
<thead>
<tr>
<th>Number of expected RTD contracts</th>
<th>Number of research grants expected</th>
<th>Number of PhD scholarships expected</th>
<th>Overall expected time commitment (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
</table>
### Unit 2 - FEDER Christophe

**Personnel of the research unit**

<table>
<thead>
<tr>
<th>n°</th>
<th>Surname Name</th>
<th>Qualification</th>
<th>University/ Research Institution</th>
<th>e-mail address</th>
<th>Months/person expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>FEDER Christophe</td>
<td>Ricercatore a t.d. - t.pieno (art. 24 c.3-b L. 240/10) (data fine contratto: 28/02/2025)</td>
<td>Università della VALLE D’AOSTA</td>
<td>OMISSIS (adesione completata il 28/03/2022)</td>
<td>4,0</td>
</tr>
<tr>
<td>2.</td>
<td>BRAGA Maria Debora</td>
<td>Professore Ordinario</td>
<td>Università della VALLE D’AOSTA</td>
<td>OMISSIS (adesione completata il 28/03/2022)</td>
<td>2,0</td>
</tr>
</tbody>
</table>

**Total cost of the research unit, per single item**

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item A.1</td>
<td>12.513 €</td>
</tr>
<tr>
<td>Item A.2.1</td>
<td>24.000 €</td>
</tr>
<tr>
<td>Item B</td>
<td>21.908 €</td>
</tr>
<tr>
<td>Item C</td>
<td>800 €</td>
</tr>
<tr>
<td>Item D</td>
<td>1.000 €</td>
</tr>
<tr>
<td>Item E</td>
<td>23.250 €</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>83.471 €</strong></td>
</tr>
</tbody>
</table>

N.B. The Item B and TOTAL columns will be filled in automatically

- Item A.1: enhancement of months/person of permanent employees
- Item A.2.1: cost of contracts of non-employees, specifically to recruit
- Item B: overhead (flat rate equal to 60% of the total personnel cost, A.1+A.2.1, for each research unit)
- Item C: cost of equipment, tools and software products
- Item D: cost of consulting and similar services
- Item E: other operating costs

**Major new contracts for staff specifically to recruit**

<table>
<thead>
<tr>
<th>Number of expected RTD contracts</th>
<th>Number of research grants expected</th>
<th>Number of PhD scholarships expected</th>
<th>Overall expected time commitment (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>0</td>
<td>12</td>
</tr>
</tbody>
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---

**Unit 3 - ZOIA Maria**

MUR - BANDO 2022
Personnel of the research unit

<table>
<thead>
<tr>
<th>n°</th>
<th>Surname Name</th>
<th>Qualification</th>
<th>University/ Research Institution</th>
<th>e-mail address</th>
<th>Months/person expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ZOIA Maria</td>
<td>Professore Ordinario</td>
<td>Università Cattolica del Sacro Cuore</td>
<td>OMISSIS (adesione completata il 29/03/2022)</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>VACCARo Gianmarco</td>
<td>Ricercatore a t.d. t. pieno (art. 24 c.3-a L. 240/10) (data fine contratto: 31/01/2024)</td>
<td>Università Cattolica del Sacro Cuore</td>
<td>OMISSIS (adesione completata il 29/03/2022)</td>
<td>2.0</td>
</tr>
<tr>
<td>3</td>
<td>RISO Luigi</td>
<td>Assegnista (data fine contratto: 30/09/2022)</td>
<td>Università Cattolica del Sacro Cuore</td>
<td>OMISSIS (adesione completata il 29/03/2022)</td>
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</table>

Total cost of the research unit, per single item

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item A.1</td>
<td>10.019 €</td>
</tr>
<tr>
<td>Item A.2.1</td>
<td>24.000 €</td>
</tr>
<tr>
<td>Item B</td>
<td>20.411 €</td>
</tr>
<tr>
<td>Item C</td>
<td>1.280 €</td>
</tr>
<tr>
<td>Item D</td>
<td>1.000 €</td>
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<tr>
<td>Item E</td>
<td>16.000 €</td>
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<tr>
<td>Total</td>
<td>72.710 €</td>
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</tbody>
</table>

N.B. The Item B and TOTAL columns will be filled in automatically
- item A.1: enhancement of months/person of permanent employees
- item A.2.1: cost of contracts of non-employees, specifically to recruit
- item B: overhead (flat rate equal to 60% of the total personnel cost, A.1+A.2.1, for each research unit)
- item C: cost of equipment, tools and software products
- item D: cost of consulting and similar services
- item E: other operating costs

Major new contracts for staff specifically to recruit

<table>
<thead>
<tr>
<th>Number of expected RTD contracts</th>
<th>Number of research grants expected</th>
<th>Number of PhD scholarships expected</th>
<th>Overall expected time commitment (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
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<td>12</td>
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</tbody>
</table>
Unit 4 - ANGELINI Eliana

Personnel of the research unit

<table>
<thead>
<tr>
<th>n°</th>
<th>Surname Name</th>
<th>Qualification</th>
<th>University/Research Institution</th>
<th>e-mail address</th>
<th>Months/person expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>ANGELINI Eliana</td>
<td>Professore Ordinario (L. 240/10)</td>
<td>Università degli Studi “G. d’Annunzio” CHIETI-PESCARA</td>
<td>OMISSIS (adesione completata il 28/03/2022)</td>
<td>1,0</td>
</tr>
<tr>
<td>2.</td>
<td>DI FEO Elisa</td>
<td>Assegnista (data fine contratto: 14/03/2023)</td>
<td>Università degli Studi “G. d’Annunzio” CHIETI-PESCARA</td>
<td>OMISSIS (adesione completata il 28/03/2022)</td>
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</tr>
</tbody>
</table>

Total cost of the research unit, per single item

<table>
<thead>
<tr>
<th>Item</th>
<th>Cost</th>
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</thead>
<tbody>
<tr>
<td>A.1</td>
<td>17.814 €</td>
</tr>
<tr>
<td>A.2.1</td>
<td>0 €</td>
</tr>
<tr>
<td>B</td>
<td>10.688 €</td>
</tr>
<tr>
<td>C</td>
<td>2.460 €</td>
</tr>
<tr>
<td>D</td>
<td>11.000 €</td>
</tr>
<tr>
<td>E</td>
<td>25.000 €</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>66.962 €</strong></td>
</tr>
</tbody>
</table>

N.B. The Item B and TOTAL columns will be filled in automatically

- Item A.1: enhancement of months/person of permanent employees
- Item A.2.1: cost of contracts of non-employees, specifically to recruit
- Item B: overhead (flat rate equal to 60% of the total personnel cost, A.1+A.2.1, for each research unit)
- Item C: cost of equipment, tools and software products
- Item D: cost of consulting and similar services
- Item E: other operating costs

Major new contracts for staff specifically to recruit

<table>
<thead>
<tr>
<th>Number of expected RTD contracts</th>
<th>Number of research grants expected</th>
<th>Number of PhD scholarships expected</th>
<th>Overall expected time commitment (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
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</tbody>
</table>

6. Information on the new contracts for personnel to be specifically recruited
<table>
<thead>
<tr>
<th>No</th>
<th>Associated or principal investigator</th>
<th>Number of expected RTD contracts</th>
<th>Number of research grants expected</th>
<th>Number of PhD scholarships expected</th>
<th>Overall expected time commitment (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>NAVA Consuelo Rubina</td>
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<td>1</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>2.</td>
<td>FEDER Christophe</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>3.</td>
<td>ZOIA Maria</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>4.</td>
<td>ANGELINI Eliana</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>Total</td>
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<td>3</td>
<td>0</td>
<td>36</td>
</tr>
</tbody>
</table>

7. PI "Do No Significant Harm (DNSH)" declaration, in compliance with article n. 17, EU Regulation 852/2020. (upload PDF)

"The data contained in the application for funding are processed exclusively for carrying out the institutional functions of MUR. The CINECA, Department of Services for MUR, is data controller. The consultation is also reserved to universities, research institutes and institutions (each for its respective competence), NUR - Directorate-General Research- Office III, CNVR, CdV, and the reviewers in charge of the evaluation peer review.
MUR also has the right to the dissemination of the main economic and scientific data related to the funded projects."

Date  
(inserted by system at the closing of the application)