Systematic Map Protocol

Title

What evidence exists on the impact of climate change on real estate valuation? A systematic map protocol

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Background

As climate risks and finance have emerged only recently as a political priority, the scientific body of knowledge linking both is, understandably, not well developed. Whereas some actors in Sweden such as Handelsbanken have published an analysis, no academic research on climate risk and material asset valuation in Sweden was found. A recent publication summarized the research challenges in evaluating the economic risks of climate change to include: 1) understanding the heterogeneity of agents, their risk preferences and vulnerability; 2) simultaneous and cascading impacts; and 3) regional heterogeneity. Understanding the methods that integrate climate risk into the value of financial assets, and real estate assets in particular, seems highly pertinent.

Theory of change or causal model

The impact pathway underpinning our research questions is visualized in Figure 1- noting that the consequences for financial stability are out of scope for the systematic map.

Stakeholder engagement

With this systematic map, we aim to identify trends and gaps in literature around the effects of exposure to climate risk on the value of real estate assets and inform a case study in Sweden, responding to a call to "systematically evaluate risks under alternative scenarios of future climatic and societal conditions" (17). The relevance and the results of our research are tested through constant engagement with the industry partners that are participating in the Vinnova-funded MAVERIC project, which aims at understanding how climate risks materialize in real estate valuation methods. Our partners represent different types of actors, including real estate owners, real estate evaluation companies, a financial institution, a government agency, and universities, all active in Sweden. This diverse perspective of our partners allows us to consider all possible impacts and methods therefore guaranteeing a holistic view of the topic.

Objectives and review question

This systematic map is intended to understand the main themes in the research literature around how climate risks affect the economic evaluation of real estate assets. • RQ1. How have climate risks for real estate markets been described in the literature? • RQ2. How have climate risks been seen to

impact real estate, and in particular real estate values? Secondary questions include: • What is the typology of natural hazards? • How are transitional climate risks considered in the literature? • How are actual damages and potential risks accounted for in economic terms?

Definitions of the question components

• Physical risks arise from climate change impacts and climate-related hazards. • Transition risks are related to the transition to a low-carbon economy. • Real estate: 1) residential assets; 2) commercial real estate; and 3) industrial real estate,. The (Population, Exposure, Comparison, Outcome) structure can be used to construct as follows: • Population: real estate assets (Offices, Industrial and Logistics, Retail, Residential, Healthcare, Hotels, etc.) Geographically, we filter to Europe and North America (USA and Canada). • Exposure: exposure to climate risks, whether physical climate risks or transitional climate risks, actual, based on a model, on future projections or on valid assumptions • Comparison: pre- and post-comparisons with the value of the asset • Outcome: a variation in the value of the assets that are subject to any form of climate risk

Search strategy

We follow the CEE approach, with our research process detailed in Figure 2. The search string is: ALL (climat* AND risk* AND (value OR economic OR financ*) AND (real AND estate OR building*)) AND (LIMIT-TO (DOCTYPE , "ar")) AND (LIMIT-TO (PUBYEAR , 2014) OR LIMIT-TO (PUBYEAR , 2015) OR LIMIT-TO (PUBYEAR , 2016) OR LIMIT-TO (PUBYEAR , 2017) OR LIMIT-TO (PUBYEAR , 2018) OR LIMIT-TO (PUBYEAR , 2019) OR LIMIT-TO (PUBYEAR , 2020) OR LIMIT-TO (PUBYEAR , 2021) OR LIMIT-TO (PUBYEAR , 2022) OR LIMIT-TO (PUBYEAR , 2023)) Our Publication databases include Scopus (Elsevier), Web of Science and Overton. No Internet search will be conducted.

Bibliographic databases

Our Publication databases include Scopus (Elsevier), Web of Science and Overton. The selection of the academic datasets is based on previous literature, which identified them as the two leading databases in systematic mapping and systematic reviewing (27); on considerations of the features that they present when compared to other alternatives such as Google Scholar, including, among many, the possibility to use complex search string with no limitations and user-friendly download and export options (28). Finally, we made the decision to turn to these datasets on account of the high quality and rigorous content selection that has been recognized through the examples of previous uses in the literature (29). We added Overton as a publication database as well. According to their website, Overton “is the world’s largest searchable index of policy documents, guidelines, think tank publications and working papers” (30). In this database, we in particular aim to grasp grey literature and commentary papers on climate risk and real estate valuation methodologies, and possible impacts of climate change on real estate valuation. Our preliminary search (see Supplementary material 1) showed that the Overton search resulted in many papers. Therefore, we limit the number of included papers from Overton to 1,000.

Web-based search engines

No Internet search will be conducted. Searches for grey literature such as working papers, opinion pieces, factsheets, policy briefs and reports will be conducted using Overton only. We note a potential lack of academic rigor, absence of a peer-review process, issues with data management, data extraction and replicability. The stakeholders of the MAVERIC project will be informed about the results of the searches and will be engaged in a discussion on the implications of the findings, but they will not be asked to contribute to the creation of the final corpus of documents.

Organisational websites

not applicable

Comprehensiveness of the search
A benchmark list of 50 relevant papers that comply with the criteria specified above (Supplementary material 3), with the inclusion criteria in Table 1 and that the reviewers deem relevant for the research has been constructed, and the corpus resulting from the search has been double checked to ensure that the search string is comprehensive enough to include these. About 75% of the articles are found among the resulting papers from the search string.

Search update
not applicable

Screening strategy
Articles will be screened at the title, abstract and full text level for the academic article screening. One of the researchers in the team will screen the full corpus on title, abstract and full text level, and 10% of it will be screened by a second reviewer for quality assurance. Where unsure, articles will be included for review to ensure no articles were left out in error. A list of excluded articles will be produced and maintained together with the reasons that led the team to opt for their exclusions. For the Overton search results, articles will be screened at title and abstract level in a first instance, and then at full text by a researcher. To ensure consistency in the screening process, a list of 200 papers will be randomly picked and screened independently at title and the abstract level by three researchers, after which the screening results will be compared. For consistency at the full text level, 20 papers will be randomly picked and screened independently. To assess the extent of agreement within the reviewing team, we will make use of a statistical measure to evaluate the robustness of the approach to potentially diverging screening standards.

Eligibility criteria
Our eligibility criteria are detailed in Table 1. Journals whose title clearly indicates that the result is not relevant for the scope of our mapping will be excluded, including, for instance, “Frontiers in Sustainable Food Systems” and “International Journal of Hydrogen Energy” and medical journals. To avoid losing potentially relevant results we will only apply such a criterion if the evidence is clear and leave the article in the retained corpus when in doubt. Before carrying out our screening, we will seek approval from our stakeholders (the MAVERIC consortium members) on excluded journal titles. We will also include the overview of excluded journals in our systematic map methodology. Geographical filtering to Europe and North America (USA and Canada) is justified by recognizing that the former represents a natural choice given that the stakeholders we engage with all operate in Sweden or in the neighbouring countries. The latter represents more than 53% of global economic losses due to natural disaster in 2022 (38). We therefore expect mature and abundant research knowledge and experience coming from this part of the world. We do acknowledge that other parts of the world are exposed to climate risk but differences in building regulation and geographic conditions might make the comparison with Europe and North America less robust.

Consistency checking
One of the researchers in the team will screen the full corpus on title, abstract and full text level, and 10% of it will be screened by a second reviewer for quality assurance. Where unsure, articles will be included for review to ensure no articles were left out in error. A list of excluded articles will be produced and maintained together with the reasons that led the team to opt for their exclusions. For the Overton search results, articles will be screened at title and abstract level in a first instance, and then at full text by a researcher.

Reporting screening outcomes
We will use the ROSES diagram to detail our findings.

Study validity assessment
We acknowledge a potential for systematic error in our evidence synthesis, which could be due to a risk of bias in the primary studies we include in our map (internal validity) but also as due to including or excluding articles that are not fit for purpose (external validity) (39). While we will not conduct a formal validity assessment (see, for example, 40), we will include in our coding framework study design elements (such as the approach used to model the risk and account for damages), which will allow to get insight into the robustness of the sample. We will also discuss with our consortium the potential for systematic error in our map, and validate the findings from our systematic map with the stakeholders (MAVERIC consortium partners), to provide some quality assurance over the robustness of our map.

Consistency checking
Articles will be screened at the title, abstract and full text level for the academic article screening. One of the researchers in the team will screen the full corpus on title, abstract and full text level, and 10% of it will be screened by a second reviewer for quality assurance. Where unsure, articles will be included for review to ensure no articles were left out in error. A list of excluded articles will be produced and maintained together with the reasons that led the team to opt for their exclusions. For the Overton search results, articles will be screened at title and abstract level in a first instance, and then at full text by a researcher.

Data coding strategy
From the final list of retained papers, a dataset consisting of authors, year of publication, journal, DOI, abstract and keywords will be populated by the reviewing team. As the topic of climate risk and real estate valuation is new, our coding framework will develop iteratively (41). Below, we detail which information we expect to extract at full text level. In addition, the authors will each read 10 papers from the retained corpus, fill in the anticipated coding framework, and make suggestions for additional data extraction. The authors will then meet to discuss the coding framework and finalise the additional categories. The coding framework will also be presented to the stakeholders (MAVERIC consortium partners) for approval in October 2023. Feedback from the stakeholders and changes to the coding framework will be documented in a systematic way. A further validation exercise will take place in the Spring of 2024 with the stakeholders, where some preliminary results will be presented. At that time, further changes to the coding framework will be discussed and finalized.

Meta-data to be coded
a dataset consisting of authors, year of publication, journal, DOI, abstract and keywords will be populated by the reviewing team. Our draft coding framework (Supplementary material 2) entails: • Climate risks considered • Location of the study: country, region or more specific geographical identification. • Approach used to model the risk and account for damages • Elements of the valuation affected • Type of buildings considered • Timeframe of the analysis • Recommendations • Scope for further analysis • Further relevant notes

Consistency checking
One of the researchers in the team will screen the full corpus on title, abstract and full text level, and 10% of it will be screened by a second reviewer for quality assurance. Where unsure, articles will be included for review to ensure no articles were left out in error. A list of excluded articles will be produced and maintained together with the reasons that led the team to opt for their exclusions. For the Overton search results, articles will be screened at title and abstract level in a first instance, and then at full text by a researcher.

Type of mapping

The coding framework will inform the mapping of our findings. To ensure that there is no double counting of findings, we will present the results from peer-reviewed publications and non-peer-reviewed papers separately. Firstly, the locations of the case studies will be mapped to identify those countries, among the economies identified in the inclusion criteria, that were subject to the largest attention by the research community. This will give the research team the possibility to understand to what extent the Swedish case has been over or underrepresented in the previous literature compared to other countries. Secondly, the geographical locations of the case studies will also be mapped against the list of natural hazards considered in the literature to generate a heatmap matrix. This will allow us to test if there is a tendency in some countries to focus on one or more natural hazards than others. It will also make it possible to assess which natural phenomena have been most frequently linked to climate risk for real estate assets. We expect those events such as tornados and hurricanes to be mostly investigated in the context of North America, where these are more common than in Europe. Such a mapping exercise will also help the research team identify those climate risks that characterize the European cases the most.

Narrative synthesis methods
A similar approach will be applied to the studies that focus on transitional climate risk, to understand the conditions, geographical, economic, political, that prompted the researchers to identify this risk as a relevant one for real estate assets. Finally, a review of the methodologies applied so far will provide directions for further research. This final presentation will be in text form, listing the methods used in research, and any shortcomings or recommendations provided in the literature on the method. The mapping will highlight the applicability of the methods in different settings.

Knowledge gap identification strategy
our heat map will highlight hazards that have been over- or under-researched, countries in focus, and methods used. It will create insight into where there are gaps in knowledge.

Demonstrating procedural independence
We pay special attention to making sure that no member of the review team is assigned a publication that she/he authored or co-authored. Should such a situation emerge, the publication will be assigned to another member of the review team. The results of the coding process are stored in a spreadsheet file format which is made available to every reader upon request.

Competing interests
The authors declare no competing interests.

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Author’s contributions
FV: conceptualization, methodology, formal analysis, writing original draft, reviewing, supervision, funding acquisition TP: investigation, formal analysis, writing original draft, reviewing ÅM: validation, writing original draft

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