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Discussion
Papers

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Transition Risks and Opportunities in Residential Mortgages

Franziska Schütze^{1,2}

Abstract

A range of studies has analysed how climate-related risks can impact financial markets, focusing on equity and corporate bond holdings. This article takes a closer look at transition risks and opportunities in residential mortgages. Mortgage loans are important from a financial perspective due to their large share in banks' assets and their long credit lifetime, and from a climate perspective due to their large share in fossil fuel consumption. The analysis combines data on the energy-performance of buildings with financial data on mortgages for Germany and identifies two risk drivers – a carbon price and a performance standard. The scenario analysis shows that expected credit loss can be substantially higher for a “brown” portfolio compared to a “green” portfolio. Taking climate policy into account in risk management and strategy can reduce the transition risk and open up new lending opportunities. Financial regulation can promote such behaviour.

Key words: Mortgages, Residential Buildings, Carbon Risks, Transition Risks, Valuation, Climate Policy Scenarios, Policy and Regulation

JEL: G21, Q48, Q56, Q58, R38

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1 Introduction

The importance of climate-related risk analyses has increased over the last years, especially since a speech by the governor of the Bank of England, Mark Carney, in 2015 where he argued that “more needs to be done to develop consistent, comparable, reliable and clear disclosure around the carbon intensity of different assets” (Carney; 2015). This has led to the establishment of the task force on climate-related financial disclosure (TCFD; 2017), which has developed guidelines on how climate-related risks should be accounted for in the governance, risk assessment and strategy of investors. Also banks are increasingly being asked to report on their ESG risks. In 2018, UNEP FI has launched the Principles for Responsible Banking, which aims at introducing and improving reporting standards for banks (UNEP FI; 2018). At EU level, banks and lending activities still play a minor role in the EU Action Plan on Financing Sustainable Growth (European Commission; 2018c). However, as part of the EU banking package of December 2018, the European Parliament and Council commissioned the European Banking Authority (EBA) to prepare a report on the integration of ESG risks into banks’ risk management and potentially into the supervisory process (European Parliament; 2018). Additionally, the taxonomy for sustainable activities, as part of the EU Action Plan on Financing Sustainable Growth (European Commission; 2018c), includes a taxonomy for “green” buildings (Technical Expert Group on Sustainable Finance; 2019). All of these initiatives aim at decreasing the information asymmetry between an investor and an investee or a lender and a borrower, with respect to climate-related risks.

A growing body of literature aims to assess the potential impact of climate change and climate policy on financial markets (Leaton; 2012; Robins et al.; 2012; Fleischman et al.; 2013; Weyzig et al.; 2014; Dietz et al.; 2016; Battiston et al.; 2017a). So far, most analyses have focused on equity markets and corporate bonds in the fossil fuel sector and in energy-intensive industries. Loans on the other hand have received less attention, and especially the subgroup of residential mortgages. This might be due to two reasons. First, disclosure on greenhouse gas emissions usually focuses on emissions from a company’s operations (scope 1 and 2 emissions)¹. In the building sector this includes the construction of the building but disregards a large part of greenhouse gas emissions caused during the operation of the building by the tenant (scope 3 emissions). Second, roughly half of residential buildings in the EU are owner-occupied buildings. Hence, the counterparties are individual households, not companies, which makes climate-related reporting harder to check and to enforce².

In light of this, residential mortgages are deemed important for five reasons: First, loans to households to finance buildings make up about 13.8% of the balance sheet of Euro Area banks (ECB; 2019), as much as loans to non-financial corporations all together. Additionally, there are loans to non-financial corporations in real estate and construction using buildings as collateral. Furthermore, insurances and pension funds are exposed to real estate and mortgages via equity holdings in real estate companies, real estate funds and mortgage bonds. During the financial crisis in 2008/09, especially financial institutions with less transparent risk exposures to mortgage-backed securities and related credit default swaps suffered from higher risk premiums (Duca et al.; 2010). Second, like other infrastructure, buildings have long investment cycles and therefore higher risks of locking in carbon emissions for several decades. Owners and investors need time to adapt, especially since mortgages are usually financed over 15-25 years (EMF; 2017). Third, (residential, public and commercial) buildings

¹Scope 1 emissions are direct emissions from the operations of the respective company. Scope 2 emissions include emissions from upstream and downstream activities in the supply chain of that company. Scope 3 emissions appear during the lifetime of the product.

²For real estate companies and real estate funds, sustainability scores are provided by GRESB (2018), an Environmental-Social-Governance (ESG) benchmark for the real estate sector.

are responsible for 30% of energy use in Germany (Öko-Institut and Fraunhofer ISE; 2016), the largest part of which is used for space and water heating, with a share of renewable energy for heating and cooling of only 13% in Germany³ (Eurostat; 2019b). Fourth, according to an analysis of the EU long-term strategy, investment needs for energy demand efficiency (EUR 270-335 bn annually) are higher than for energy supply (EUR 133-246 bn annually) (European Commission; 2018b). Fifth, green mortgage bonds are a growing market, having grown from USD 19 bn in 2016 to USD 45 bn in 2017⁴. However, if green mortgage bonds are only used to reclassify new buildings (with efficiency labels A-B) as opposed to existing buildings (with labels C-H), it might have no influence on investments into energy efficiency and renewable energy in buildings. Investors need to be able to compare the climate risk of all mortgage bonds, not only of green mortgage bonds.

By reviewing climate policies for the building sector in Europe, this paper identifies different transition scenarios – an increase in energy prices and the introduction of a performance standard for existing buildings. Using Germany as an example, the potential effect of these transition scenarios on a “brown” and a “green” mortgage portfolio is assessed. It integrates data on the energy-performance of buildings into an expected credit loss calculation of a mortgage portfolio. Additionally, it provides a discussion on how banks can align their mortgage portfolio with the Paris Agreement and national policy goals. By including energy efficiency into strategic decisions and product development, one can identify lending and investment opportunities to households and to industries, that benefit from the transition.

This analysis can be useful for banks, who are increasingly being asked to assess and disclose their climate-related risks and their alignment with climate policy goals. Additionally, it can be used by investors at the level of individual securities, e.g. by comparing the transition risk of a green mortgage bond versus a standard mortgage bond. Furthermore, it is important for policy makers, who want to align financial policies with ambitious climate policies.

This paper is organized as follows. Section 2 presents background and literature on the topic. Section 3 explains the method applied. Section 4 explains the data used to construct portfolios and scenarios. Section 5 presents the results, which is followed by a discussion and conclusion in Section 6 and 7.

2 Background

2.1 Climate targets and policies

The European Union has three targets under the 2030 climate and energy framework (European Commission; 2018a): 40% greenhouse gas emissions reduction target (compared to 1990), 32% renewable energy target and a 32.5% energy efficiency target. To reach these targets, the Energy Performance of Buildings Directive (EPBD) (2018/844/EU) (EU; 2018) provides the policy framework for buildings. It demands mandatory energy performance certificates (EPCs) in advertisements for the rental or sale of a building and minimum performance requirements for new buildings and major renovations of old buildings. Targets are implemented at the national level, mostly through building codes, labels and financial incentives. As part of the EU Action Plan on Financing Sustainable Growth (European Commission; 2018c), a taxonomy for sustainable activities and investments has recently been

³Gas and mineral oil were still the main energy sources, with 44% and 26% of energy use, respectively.

⁴The first green mortgage bond of EUR 500 mln was issued by Obvion (a subsidiary of Rabobank) in 2016. In 2017, the US federal national mortgage association (The multi-family branch of Fannie Mae) contributed the largest bond with a volume of USD 27.6 bn.

proposed (Technical Expert Group on Sustainable Finance; 2019). The current proposal for green buildings includes new buildings, if they are built as net-zero energy building (NZEB)⁵ and if they have an EPC of B or better⁶, and building renovations, if they increase the energy performance by at least 30% and if they comply with the building code for major renovations.

In Germany, at the national level, the climate change plan (*Klimaschutzplan 2050*) provides the policy framework (BMUB; 2016). The plan outlined a national target of 80% reduction of greenhouse gas emissions by 2050 (40% by 2030) compared to emissions in 1990. For buildings, the target is a reduction of 80% of primary energy use by 2050 compared to 2008 (and 40% by 2030) and a 50% share of renewable energy for heating and cooling. On the legislative side, Germany introduced a mandatory building code, the Energy Savings Ordinance (*Energieeinsparverordnung*) in 2002, as implementation of the first Energy Performance of Buildings Directive at EU level. This Ordinance complemented the Thermal Insulation Ordinance (*Wärmeschutzverordnung*), which was introduced in 1977. The Energy Certificate for Buildings (*Energieausweis für Gebäude*) was introduced in 2008 and the Heating Act (*EEWärmeG*) in 2009. Financial incentives are provided by the national development bank, KfW, via its “energy-efficient construction and refurbishment program” (IWU and Fraunhofer IFAM; 2018), which offers reduced-rate loans and subsidies for different energy-efficiency measures and renewable energy installations.

As the first country to introduce a feed-in-tariff (FiT) for renewable electricity, Germany tripled its share of renewable electricity in gross electricity consumption within 10 years – from 11.8% in 2006 to 32.2% in 2016 (Eurostat; 2019b, nrg_ind_335a). However, Germany only doubled the share of renewable energy for heating and cooling in the same timeframe – from 7% in 2006 to 13% in 2016 (Eurostat; 2019b, nrg_ind_335a). Studies investigating the effectiveness of renewable energy policies, indeed show that the feed-in-tariff is the most effective policy in promoting renewable energy investments, mainly because it reduces investment risk and increases returns at the same time (Polzin et al.; 2019). Similar studies on the effectiveness of climate policy for energy efficiency and renewable energy for heating are currently missing.

2.2 Risk management and strategy development

Weber et al. (2008) find that environmental risks and sustainability criteria are increasingly being incorporated in the credit risk management process (divided into 5 phases: rating, costing, pricing, monitoring, work out) of financial institutions, especially among signatories of the UNEP Principles of Responsible Investment (UN PRI). However, the authors find that especially in the costing stage of the credit risk management process, where expected loss is quantified, only few respondents take environmental credit risk into account.

The stress-test of large European Banks, performed by the EBA, requires banks to assess the impact of two different scenarios on their balance sheet, a baseline and an adverse scenario (EBA; 2018). A major change in the EBA stress-test of 2018 was the introduction of the International Financial Reporting Standard 9 (IFRS9), which was implemented in the EU in 2016 (European Commission; 2016). IFRS9 entails that credit impairment is calculated over the lifetime of the loan (as opposed to only 12 months) and that “expected” credit losses have to be reported (as opposed to “incurred” credit losses). The latter requires banks to include forward-looking macroeconomic variables (EBA; 2018). These changes in the stress-test

⁵According to the EPBD, all new buildings should be built according to the NZEB standard by 2020. However, there is no common definition of NZEB among European countries.

⁶The criteria will be reviewed and revised, to ensure that the threshold is above the top 15% of the local building stock.

procedure would allow to include other forward-looking variables, such as socio-ecological variables. However, the integration of climate-related risks in credit risk analysis is still at an early stage. Along these lines, the TCFD recommends to establish a process to identify, assess and manage climate-related risks (TCFD; 2017). The recommendations explicitly contain the use of forward-looking scenarios for the purpose of risk management and for developing strategies to address these risks.

Following the definition of the TCFD (2017), there are transition risks (policy, technology, market and reputation) and physical risks (acute and chronic). Table 1 provides examples for these risk categories for buildings in particular. Regarding physical risks, Hirsch et al. (2015) estimate the annual expected loss (AEL) for selected locations in Germany caused by different extreme weather events (flood, hail, storm) at property-level. Using 15 example locations, the authors demonstrate how the tool can be used to better understand the impact of extreme events in the future. The scenario analysis in this paper focuses on transition risks.

Regarding transitions risks, the literature on sustainability in real estate mainly addresses two types of questions: 1) whether sustainable real estate carries lower default risks and 2) whether energy-efficient and sustainable buildings have a higher market value, hence sell at a premium. Most studies are from the US, UK or Australia and focus mainly on commercial real estate. Regarding the first question, the default risk of sustainable real estate, Kaza et al. (2014) find that mortgages on energy-efficient homes (characterized by the Energy Star label) have significantly lower default risks (one-third lower) than other buildings. Similarly, An and Pivo (2018) find lower default rates in commercial mortgage-backed securities (CMBS) for buildings certified as “green” under Energy Star or LEED. Concerning the second question, the valuation of sustainable real estate, Krause and Bitter (2012) identify sustainability as one of three main trends in real estate valuation literature. Warren-Myers (2012) examines the link between sustainability and value from a classical valuation perspective. The study highlights the role of valuers and advisers, and discusses how sustainability can be incorporated by valuation professionals and which measures are most applicable. So far, most studies on valuation effects of sustainability are from the United States, where premiums for Energy star and LEED buildings for commercial real estate in the US were found to be 16-17% higher (Eichholtz et al.; 2010). For Europe, Bio Intelligence Service et al. (2013) found positive effects on the sales price of a one letter improvement of energy efficiency of 8% in Austria, 4.3% in France and 2.8% in Ireland. However, the availability of data at the sector-level needs to be improved. For Germany, Surmann et al. (2015) assess the influence of energy efficiency on the market value of office buildings. Due to the small sample size, no conclusive evidence could be established.

Additionally, to identify lending opportunities from sustainability in the residential mortgage market and to offer dedicated energy efficiency products, it is important to better understand the drivers and barriers of energy efficiency investments. Ameli and Brandt (2015) find that home-owners and high-income households are more likely to invest into energy conservation. Additionally, environmental attitudes play an important role. Comerford et al. (2018) find that the introduction of color-letter grades (A = green, B = yellow, C = orange, D-G = red) on the English Energy Performance Certificate (EPC) motivated vendors to invest in energy efficiency. The authors find that in the period after the adoption of the color-letter grading system in 2007 more houses moved just above the D-grade threshold (the red colour). Hamilton et al. (2016) argue that if lenders include energy performance in mortgage calculations it would have a negative effect on the value of energy-intensive buildings and increase the affordability of more efficient houses. Furthermore, there is evidence that sustainability in the real estate sector is regarded as a positive signal by investors and shareholders. An event study by Ansari et al. (2015) finds that sustainability

reporting under the Global Reporting Initiative (GRI) has a positive impact on the value of listed real estate companies in Europe, USA and Australia.

3 Method

This paper follows the TCFD recommendations of identifying, assessing and managing climate-related risks. First, to identify climate-related risks, a review of climate policies for the building sector in the EU is provided. Second, to assess the risk, possible transition scenarios are integrated into a credit risk analysis. Third, possible strategies for adjusting the portfolio and identifying opportunities are discussed.

According to (Ganguin and Bilardello; 2004, p.289) “credit scoring [...] is an essential tool for pricing debt instruments and for credit risk management”, consisting of default risk on the one hand and recovery expectations on the other hand. The credit risk of a mortgage loan can also be divided into these two components, the default risk of the borrower and the valuation of the building (determining the recovery expectation). This paper applies a common framework used by banks and financial regulators to determine credit risk, expected credit loss.

The standard expected credit loss (*ECL*) is derived as follows:

$$ECL = EAD \times PD \times LGD \quad (1)$$

where *ECL* is the expected credit loss, *EAD* is the exposure at default, *PD* is the probability of default and *LGD* is the loss given default.

Applying this method for climate-related credit risks has been suggested by UNEP FI and OliverWyman (2018). However, the UNEP FI report focused on only one factor of the equation, the probability of default (*PD*) and does not apply the framework to the real estate sector or to mortgages. The “carbon quick scan tool” (Camphuis et al.; 2018; Hähl et al.; 2019) applied the expected loss model for different asset classes, including mortgages. However, it focuses on a change in loss-given default (*LGD*) and does not perform an analysis of different scenarios and portfolios. To include different risk drivers, the method used in this paper combines insights from UNEP FI and OliverWyman (2018) and the “carbon quick scan tool” (Camphuis et al.; 2018), by analysing potential effects on the solvency of the borrower and the value of the building. Hence, the analysis is extended in several points. First, different transition scenarios, which can have an impact on the risk factors, are identified. Second, climate-related changes in *LGD* as well as in *PD* are included in the analysis. Third, adjustments in the exposure at default (*EAD*) are made, comparing a “brown” and a “green” mortgage portfolio, to evaluate risk mitigation options and to inform strategic decisions.

As *PD* and *LGD* are usually derived from historical data, two analytical challenges need to be kept in mind. First, there is a lack of historical data that combines default rates and valuation with the energy performance of buildings. Second, the energy transition requires a major economic restructuring, which requires forward-looking estimates as well. Providing estimates of climate-related risks requires knowledge of climate change scenarios, potential policy responses, market developments and technological developments. To identify different forward-looking risk factors for buildings, the categorization of the TCFD (2017) is applied. Table 1 shows examples for each of the different risk types in the building sector. These potential risks will have an influence on the risk profile of the borrower and the value of the collateral.

Table 1: Impact of different climate-related risk types on buildings.

Risk category	Type	Example in the building sector
Transition risk	Policy and legal	Increasing carbon price or carbon tax (e.g. Sweden and Switzerland), enhanced performance standards for existing buildings (e.g. the Netherlands and the UK).
	Technology	Substitution of existing products/technologies due to technological innovation.
	Markets	In/decreased costs of raw materials (e.g. concrete, steel, wood, insulation, etc.) In/decreased energy prices (e.g. due to geopolitical changes).
	Reputation	Shift in consumer preferences leading to higher demand for energy-efficient houses (energy-intensive buildings selling at a discount).
Physical risks	Acute	High rebuilding costs due to storms, floods or other extreme weather events.
	Chronic	Increasing insurance premiums in coastal areas and along rivers.

The Expected credit loss including transition risks is derived with the standard formula extended by a climate factor:

$$Climate\ ECL = EAD \times (PD + climate\ PD) \times (LGD + Climate\ LGD) \quad (2)$$

where *climate PD* is the additional probability of default due to transition risks and *climate LGD* is the additional loss given default due to transition risks. The mortgage portfolio is divided into different classes depending on their energy performance certificate. The *climate PD* and *climate LGD* are calculated for each class of buildings. The size of the climate factors (*climate LGD* and *climate PD*) depends on the sensitivity of *PD* and *LGD* to the shock. The *climate PD* is estimated using the increase of energy expenses, E , over income, I , times a sensitivity factor. The *climate LGD* is estimated using the required investment, I , as share of the market value of the asset, V , times a sensitivity factor:

$$Climate\ PD = \left(\frac{E}{I} \right) \times PD\ sensitivity \quad (3)$$

$$Climate\ LGD = \left(\frac{Inv}{V} \right) \times LGD\ sensitivity \quad (4)$$

Table 2 shows how the different components of the expected credit loss calculation can be influenced by transition scenarios. Since the focus of this paper lies on transition risks in buildings, the energy performance certificate (EPC) is used as the main environmental indicator. Since the introduction of the Energy Performance of Buildings Directive (EPBD), it is the most widely used performance indicator for buildings in Europe. Some performance measures include the construction or major refurbishment of a building (Such as LEED, BREEAM, DGNB⁷). Others focus only on the operation of a building, mainly the energy

⁷LEED is a certification program for green buildings in the US and internationally, developed by the non-profit U.S. Green Building Council (USGBC). BREEAM is a certification program in the UK, developed by the Building Research Establishment. It has been introduced to other European countries as well. DGNB is a certification program in Germany, developed by the German Sustainable Building Council.

consumption (such as “Energy Star”⁸ in the US or the EPC in the EU) but also the water consumption or waste production. Rogmans and Ghunaim (2016) provide an evaluation framework for different sustainability indicators in the real estate sector. The analysis can be extended by using additional sustainability indicators.

Table 2: Description of how the transition can influence risk factors.

Risk factor	Baseline Scenario	Transition Scenarios
EAD	Given in the short-term by the lending strategy	Can be changed in the long-term through strategic reallocation of loans.
PD	Influenced by macroeconomic conditions (unemployment level, GDP, interest rates, inflation)	Increase of energy prices (geopolitical) or energy/carbon taxes (market and policy risks), insurance costs (physical risks); revenue decrease (changing consumer preferences lead to lower rents and higher vacancy rates)
LGD	Depends on location and characteristics of the asset, market liquidity etc.	Renovation requirements reduce the market value of the asset, either over time or suddenly (policy risk).

4 Data

To perform a scenario analysis, mortgage loans outstanding in Germany are used to provide a first overview of the transition risk in the German mortgage market. This data is then connected to energy and climate scenarios, by using the current distribution of energy labels of buildings and the emission reduction targets for buildings in 2050.

4.1 Scenarios

Incentives and price signals for investments in energy efficiency and renewable energy for heating appear insufficient to stimulate the necessary investments, such that the national and EU emission reduction targets will be reached. According to Blazejczak et al. (2014), Dena (2016) and BCG and Prognos (2018), the national target of 80% reduction in primary energy use and a 50% share of renewable energy by 2050 can only be reached if the annual renovation rate is increased from the current 1% to at least 2%.

Several potential transition shocks are conceivable, when comparing policies with other European countries. All countries have introduced a national building code for new buildings, a label for very efficient houses or net zero energy buildings (NZEB) and several incentives for investments into efficiency and renewable energy in buildings. A comparison of CO₂ prices, gas prices, the share of renewable energy and the share of energy-intensive buildings is provided for different European countries in Table 3. According to the IEA policy database (IEA; 2019) as well as the Odysee-Murrey database (Odysee-Mure; 2019) the amount of policy measures differs quite substantially between countries. However, some countries in the Euro Area and the EU have already introduced a CO₂ price (mostly in the form of a carbon tax) for emissions in the sectors not covered by the EU-Emission Trading System (EU-ETS) such as transport and heat (non-ETS sectors). For countries that adopted a

⁸Energy Star is a voluntary labelling program by the EPA in the US. „Leadership in Energy and Environmental Design“.

CO₂ price, the price varies substantially, where Sweden is at the top rank (World Bank and Ecofys; 2018) with 139 Euro per ton. Sweden also has the highest gas price for households consumers (including all taxes and levies) in the EU (Eurostat; 2019b). Some EU countries have introduced a regulation that prohibits building owners to rent out inefficient houses after a certain year. In the Netherlands this applies for commercial buildings with label D or worse after 2023, and in the UK for all residential buildings with E or worse after 2020. Even in the absence of such regulatory measures, Comerford et al. (2018) found that a colour-letter grade can have an effect on consumer preferences, especially buildings with an energy label E or worse (red colour). Once the share of energy efficient houses increases, a tipping point might be reached and prices of energy-intensive buildings might decrease much faster, especially in areas with high vacancy rates, e.g. some rural areas.

Table 3: Carbon prices and energy prices for heat, share of renewable energy and share of energy-intensive buildings (label D-H). For countries of the Euro Area, plus 3 additional EU countries; the UK, Denmark and Sweden due to the size of their mortgage market.

* Indicates that the country has already reached its 2020 target.

Country	Carbon price for non-ETS sector (Euro/ton)	Gas price for households (Euro/kWh)	Share of renewable energy: heating & cooling (gross final energy consumption)	Buildings with energy label D-H
Belgium	0	0.054	8.1% (8.7%)	67%
Germany	0	0.061	13% (14.8%)	62%
Ireland	25	0.063	6.8% (9.5%)	48%
Spain	0	0.067	16.8% (17.3%)	96%
France	55	0.067	21.1% (16.0%)	65%
Italy	0	0.071	18.9% (17.4%*)	85%
Netherlands	0	0.082	5.5% (6.0%)	55%
Austria	0	0.067	33.3% (33.5%)	n.A.
Portugal	8	0.076	35.1% (28.5%)	68%
Finland	77	n.A.	53.7% (38.7%*)	60%
UK	25	0.046	7.0% (9.3%)	64%
Denmark	29	0.090	41.7% (32.2%*)	62%
Sweden	139	0.113	68.6% (53.8%*)	n.A.
Source	(World Bank and Ecofys; 2018)	(Eurostat; 2019b)	(Eurostat; 2019b)	(Enerdata; 2016)

Two main risk drivers can be identified from reviewing European policies on energy efficiency in buildings, an energy-price increase and a performance standard for existing buildings. The energy price used for the baseline scenario of this analysis is based on the current gas prices for household consumers in Germany (EUR 6 ct/kWh in 2018). If the government (at national, EU or international level) would introduce a CO₂ price of 100 Euro/ton (or 180 Euro/ton as recently proposed in Germany for the year 2030) for heating

oil and gas, it would lead to an increase of the fuel price by approximately 2.5 ct/kWh (or 4.5 ct/kWh, respectively).⁹ Based on the current price of 6 ct/kWh this would lead to an increase to 8.5 ct/kWh (or 10.5 ct/kWh, respectively), which is close to the current price in Sweden. This is in line with forecasts by Öko-Institut and Fraunhofer ISE (2016), which projects an increase of gas and oil prices from 6-7 ct/kWh today to 8-13 ct/kWh in 2030 (average 10.5 ct/kWh) and 9-21 ct/kWh in 2050 (average 15 ct/kWh). Hence, 10.5 ct/kWh is used for the low energy price scenario and 15 ct/kWh is used for the high energy price scenario.

An energy performance standard for existing buildings would lead to a reduction of the market value for energy-intensive buildings. The value difference is determined by the required investment for renovation to upgrade the building to a better energy performance label (to be able to operate it and to keep it attractive in the future). The renovation costs are adopted from BCG and Prognos (2018), who estimate total costs to be between 285 - 465 Euro/m² for multi-family homes and 425 - 590 Euro/m² for single family homes. The former is used for the low investment cost scenario and the latter is used for the high investment cost scenario (for energy labels D-H). Similarly, investments financed via the “energy-efficient renovation” program of KfW were in the order of 398 Euro/m² on average¹⁰, which is in line with the average of the low investment cost scenario.

Investment subsidies as well as promoting low-carbon innovation in the building sector would reduce the renovation costs. Hence, depending on the policy approach in a country, this value difference can be lower, mitigating the risk of a value loss. Table 4 describes three different theoretical scenarios and their impact on risk factors, which were derived from potential transition shocks.

Table 4: Description of the different scenarios resulting from different shocks.

Scenario	Shock cause (and main driver)	Impact on risk factor
Scenario 1	Introduction of a performance standard (policy risk) or change in consumer preferences (reputation risk)	Decline in house prices, leading to higher LGD for buildings with label D-H
Scenario 2	Introduction of a carbon price or increase in energy prices (policy or market risk)	Higher operating costs, leading to higher PD
Scenario 3	Combination of Scenario 1 and 2	Leading to higher PD and LGD

4.2 Portfolios

Commercial and residential buildings owned by non-financial corporations are usually financed via corporate loans and equity (listed or non-listed) and are therefore usually covered in sector analyses that include the real estate sector (e.g. Battiston et al. (2017b)). However, residential buildings owned by individuals (which are often also owner-occupied) are largely financed through private bank loans, and are therefore not covered in most sectoral climate risk analyses.

⁹Using an average carbon intensity factor of 0.25kg CO₂/kWh for gas and oil and a carbon price of 100 or 180 Euro per ton (0.10 or 0.18 Euro/kg CO₂), results in 2.5 ct/kWh (or 4.5 ct/kWh, respectively). 1 kWh is equal to about 0.1 liter of heating oil.

¹⁰Total investments of 10.1 bn Euro for 276,000 residential units in 2016 IWU and Fraunhofer IFAM (2018), which is 36,600 Euro per unit, assuming an average floor space of 92 m².

The “brown” and “green” portfolio used for this scenario analysis combines data of the German building stock and outstanding bank loans for residential buildings in Germany (ECB; 2019) with data on the national distribution of energy labels (Dena; 2018) and national climate policy targets. In 2018, the amount of building-related loans by German banks consisted of EUR 1,229 bn in loans for house purchases and residential buildings by households (ECB; 2019). Compared to the aggregate balance sheet of German banks of EUR 7,880 bn, this amounts to approximately 15.6% of total assets. The share is higher than loans to non-financial corporations, with EUR 1,042 bn (ECB; 2019). The situation is similar for other European countries, as can be seen in Table 5. The countries with the largest mortgage loan market in the EU are Germany, France and the UK. The average loan-to-value (LTV) ratio in Germany is 80% (meaning that on average buildings are financed with 20% equity), however, there are also loans which are finance with 100% (EMF; 2017). Only 20% of mortgages are financed with short-term (less than 5 years) or variable interest rates (EMF; 2017), meaning that for 80% of mortgages banks cannot easily adjust interest-rates, even if the default risk increases. The relative size of mortgage loans and their long credit lifetimes make it an important asset class for forward-looking risk analyses.

Table 5: Aggregate balance sheet of banks (MFIs) and breakdown of loans to other banks (MFIs), non-financial corporations (NFCs) and households (HH) for house purchases. For countries of the Euro Area, plus 3 additional EU countries; the UK, Denmark and Sweden due to the size of their mortgage market. Source:(ECB; 2019)

Country	Total assets of Banks (MFIs) in Euro	Loans to MFIs in Euro	loans to NFCs in Euro	Loans to HH for house purchases in Euro
<i>Euro Area</i>	<i>31,393</i>	<i>6,724</i>	<i>4,423</i>	<i>4,339</i>
Belgium	1,043	209	142	164
Germany	7,880	1,901	1,042	1,229
Ireland	1,042	146	54	76
Spain	2,664	324	473	518
France	9,100	2,554	1,066	1,039
Italy	3,692	562	708	380
Netherlands	2,390	332	378	473
Austria	857	171	178	112
Portugal	394	32	72	95
Finland	648	143	88	98
UK	9,164	544	486	1,381
Denmark	1,075	125	159	294
Sweden	n.A.	n.A.	n.A.	n.A.

The building stock in Germany consists of 40.3 million residential building units, of which 18.8 million are single- and dual-family homes and 21.5 million are multi-family homes (Dena; 2018). The average living space per unit is 92 m² (3.7 bn m² floor space

in total). In 2017, 51.7% of the population lived in owner-occupied houses, below the European average of 69.2% (Eurostat; 2019a), half of which have an outstanding loan or mortgage. Approximately 1% of buildings are being renovated each year and about 0.6% are new constructions (245,000 in 2017 (Destatis; 2018)). In 2016, 1 million transactions were made in the property market in Germany, with a value of EUR 237.5bn (AK OGA; 2017). The share of residential property was 72% (727.400 transactions, about 1.8% of residential building units), with a value of EUR 155.7 bn. This means that only about 1/3 of the transactions are new constructions and 2/3 are existing buildings. Hence, given that EUR 1,229 bn constitute the outstanding loans for residential buildings by households for half of the owner-occupied residential building units in Germany (10 million units), this would result in an average outstanding loan of 122,900 Euro/unit. According to (BBSR; 2017, p.13) the average price for single or dual-family houses in Germany in 2016 was 1,545 Euro/m², which would result in an average value of approx. 142,000 Euro for 92 m² (for most locations the price range is between 1,000 and 2,500 Euro/m², but can be up to 8,500 Euro/m² in Munich). The average household net-adjusted disposable income (after taxes and transfers) in Germany was USD 34,297, or 30,900 Euro¹¹, per year in 2016 (OECD; 2019).

For the “brown” portfolio, the distribution of energy performance certificate (EPC) in Germany is obtained from the building report of Dena (2018). According to Dena, the energy consumption per m² has improved from 150 kWh/(m²a) in 2008 (Dena; 2016) to 135 kWh/(m²a) in 2015 (Dena; 2018). In 2016, 50% of buildings consumed more than 140 kWh/(m²a), and the least efficient buildings consumed up to 300-400 kWh/(m²a). The average energy consumption of single- and dual-family homes built before 1978 is between 140-160 kWh/(m²a) and multi-family homes built before 1978 between 110-140 kWh/(m²a). The share of buildings in different energy performance categories (label A to H) was estimated from the building report of Dena (2018) and are depicted in Figure 1.

For the “green” portfolio, it is assumed that the number of outstanding loans by banks are the same as for the “brown” portfolio, but that the bank integrates energy efficiency goals into the risk management process and its strategic decisions. Over time, this would result in a portfolio with only energy-efficient buildings (label A and B), in line with the climate target for 2050. Such a portfolio is also in line with existing definitions of “green” mortgage bonds¹². A fully renovated building can reach average values of energy consumption of 50-60 kWh/(m²a) (Dena; 2016), which means that, theoretically, all renovated buildings can reach energy label B. The description of the portfolios is summarized in Table 6 and Figure 1.

Table 6: Description of the two different portfolios.

Brown portfolio (baseline portfolio)	Green portfolio (2050 policy-compatible)
This portfolio uses the current distribution of German residential buildings for different energy classes.	This portfolio is in line with current definitions of green mortgage bonds (and would meet the national target for the average energy consumption of 40 kWh/(m ² a) by 2050).

¹¹Using an annual average exchange rate of 1.11 (1 Euro = 1.11 USD) in 2016, according to the European Central Bank.

¹²e.g. “Muenchener Hypothekenbank eG” in Germany include only buildings with energy label A or B in their green mortgage bonds.

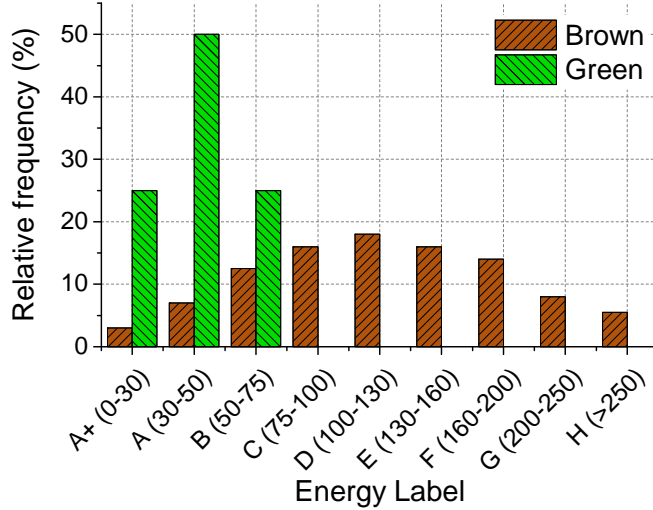


Figure 1: Distribution of houses by energy segment for the current (“brown” portfolio and a “green” portfolio.

5 Results

5.1 Risk assessment: impact of different scenarios

To calculate the valuation shock for Scenario 1, the average renovation costs for each building segment, that might be subject to a performance standard (energy label D-H), is computed as percentage of the average value of a housing unit, as described in Section 3: e.g. buildings with an energy label F (average energy use: 180 kWh/(m²a); size: 92 m²), an average value of 142,000 Euro and renovation costs of 375 Euro/m² :

$$\frac{(92 \text{ m}^2 \times 375 \text{ Euro/m}^2)}{142,000 \text{ Euro}} = 24.3\% \quad (5)$$

This means that for a house with an average value and an energy label F, the owner would need to invest 24.3% on upgrading the house, which would reduce its market value.

To derive the energy price shock for Scenario 2, the increase in energy costs for each segment (energy label A-H) as a percentage of the average household income is derived, as described in Section 3: e.g. for buildings with an energy label F (average energy use: 180 kWh/(m²a); size: 92 m²) and an energy price increase from 6 to 10.5 ct and an average household income in Germany in 2016 (30,900 Euro):

$$\frac{92 \text{ m}^2 \times 180 \text{ kWh/ (m}^2\text{a)} \times (10.5 \text{ ct} - 6 \text{ ct})}{30,900 \text{ Euro}} = 2.4\% \quad (6)$$

This means that a household with an average income and a house with energy label F would need to spend 2.4% of its income on additional energy costs.

The resulting average additional annual energy costs and estimated renovation costs for each energy label are reported in Table 7. In Scenario 1, the potential value loss varies between 15.5% and 30.1% (for label C to H) in the low cost scenario and between 24.9% and 38.2% (for label C to H) in the high cost scenario. In Scenario 2, the potential income loss varies between 0.2% and 4.4% (for label A to H) in the low cost scenario and between 0.4% and 8.7% (for label A to H) in the high cost scenario.

In a second step, the impact of three different scenarios on expected credit loss, given the current “brown” portfolio and the aggregate mortgage portfolio of all banks in Germany of 1,229 bn Euro, was estimated:

Table 7: Value and income effect of Scenario 1 and Scenario 2 (with low and high costs) on different building classes (A+ to H)

Energy label <i>kWh/(m²a)</i>	Scenario 1 <i>Euro (% of value)</i>		Scenario 2 <i>Euro / year (% of income)</i>	
	low	high	low	high
A+ (0-30)	-	-	62 (0.2%)	124 (0.4%)
A (31-50)	-	-	166 (0.5%)	331 (1.1%)
B (51-75)	-	-	259 (0.8%)	518 (1.7%)
C (76-100)	22,080 (15.5%)	35,305 (24.9%)	362 (1.2%)	725 (2.3%)
D (101-130)	26,220 (18.5%)	39,100 (27.5%)	476 (1.5%)	952 (3.1%)
E (131-160)	30,360 (21.4%)	42,895 (30.2%)	600 (1.9%)	1,201 (3.9%)
F (161-200)	34,500 (24.3%)	46,690 (32.9%)	745 (2.4%)	1,490 (4.8%)
G (201-250)	38,640 (27.2%)	50,485 (35.6%)	932 (3.0%)	1,863 (6.0%)
H (251+)	42,780 (30.1%)	54,280 (38.2%)	1,346 (4.4%)	2,691 (8.7%)

- Scenario 1 (low costs): a decrease in the market value of buildings with label D-H due to an energy performance standard (assuming that C buildings will not be part of the performance standard at first).
- Scenario 2 (low cost): an increase in energy prices due to the introduction of a carbon price (affecting all buildings depending on their energy label).
- Scenario 3: a combination of scenario 1 & 2, assuming that an increase in energy prices would trigger a value adjustment or vice versa, hence assuming a correlation between *PD* and *LGD*.

These scenarios simulate possible changes in policy or consumer preferences, which might change the risk profile of a bank’s mortgage portfolio. For the purpose of this scenario analysis, it is assumed that the impact on the value of the house is stronger than the effect of the increase energy costs on default rates, because households can adjust their consumption or because a CO₂ price could be redistributed per capita. Furthermore, if a CO₂ price is redistributed to households, the income effect will be lower. Therefore, a sensitivity of *PD* of 0.5 and a sensitivity of *LGD* of 0.75 was chosen. Resulting changes in expected loss for each energy label, depending on the scenario, are depicted in Figure 2.

For the “brown” mortgage portfolio, expected loss increases by 124% for Scenario 1 (performance standard), by 51% for Scenario 2 (increase in energy price) and by 256% for Scenario 3 (the combined scenario), compared to the baseline scenario. Potential losses concentrate on the energy-intensive buildings, the right-hand side of the distribution.

5.2 Risk management: impact on brown and green mortgage portfolio

To demonstrate the possibility of portfolio adjustments, the impact of the scenarios on two different portfolios, a “brown” and a “green” portfolio is compared. Using the aggregate mortgage portfolio of all banks in Germany of 1,229 bn Euro, and repeating the risk assessment for the “green” portfolio, leads to no increase of expected loss for Scenario 1 and a 16% increase of expected loss for Scenario 2 and 3. Hence, the “green” portfolio (such as a “green” mortgage bond) is considerably less sensitive to transition risks than a “brown” mortgage portfolio (a standard mortgage bond). Results are presented in Table 8.

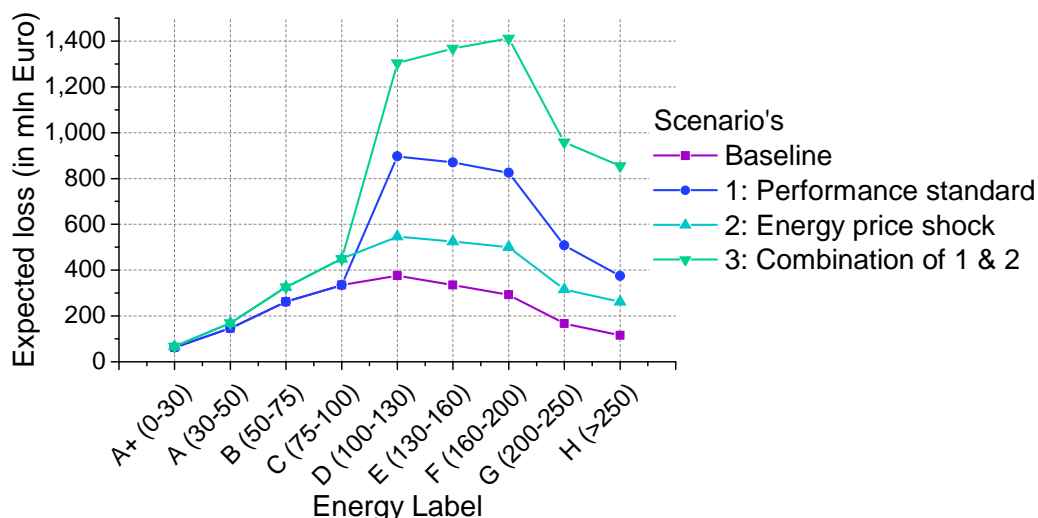


Figure 2: Expected credit loss for the current (brown) portfolio in three scenarios.

Table 8: Expected credit loss (ECL) for the “brown” and “green” portfolio. Comparison of 3 different scenarios with the baseline scenario.

Portfolio and Scenario	ECL in Euro	% increase compared to baseline scenario	ECL as % of the mortgage portfolio
“brown” portfolio			
- Baseline scenario	2,089 mln	-	0.17%
- Scenario 1 (low)	4,670 mln	124%	0.38%
- Scenario 2 (low)	3,160 mln	51%	0.26%
- Scenario 3	7,430 mln	256%	0.60%
“green” portfolio			
- Baseline scenario	2,089 mln	-	0.17%
- Scenario 1 (low)	2,089 mln	-	0.17%
- Scenario 2 (low)	2,413 mln	16%	0.20%
- Scenario 3	2,413 mln	16%	0.20%

The size of the effect needs to be verified in future work, which requires more detailed data on portfolio distributions and sensitivities. However, the likelihood, and the timing of transition risks to unfold, involves different uncertainties. Therefore, the adoption of risk mitigation measures will depend on the investors’ beliefs about the probability of policy interventions and technological progress to occur.

The lender can strategically manage the distribution of energy labels in financed buildings, hence the exposure at default (EAD) for each energy label. This can be done by shifting the portfolio towards more energy-efficient buildings over time, either by not offering new loans (or renewing loans) for energy-intensive buildings (absent a plan for retrofitting the building) or by adjusting the interest rate depending on the energy efficiency of a building. Early action is important due to the low renovation rates as well as long investment cycles and lifetimes of mortgage loans. Considering the long credit lifetimes of mortgage loans, the 2050 policy target should be used as a reference point.

In light of the growing green mortgage bond market and the introduction of the EU taxonomy for sustainable activities, there is a risk that banks only reclassify all buildings

with an energy label A (and B) in their portfolio as “green”, and refinance them via “green” mortgage bonds. On the one hand, this would leave all remaining buildings in the standard portfolio (but no A and B buildings anymore) and therefore increase the transition risk in the standard portfolio. On the other hand, it might not lead to increased investments in energy efficiency. Since about 20% of buildings in Germany already have label A or B, a bank will have to increase its share of green buildings to more than 20% to have a (positive) influence on energy efficiency investments. A target, which is in line with policy goals, would be at least 40% by 2030 and 100% by 2050. Green mortgage bonds of different issuers should be seen in the context of the whole portfolio of the issuer.

5.3 Strategy: Identifying opportunities

The same data can be used to identify business opportunities. The transition from the “brown” portfolio to a “green” portfolio determines the investment needs and hence the lending opportunities. According to the assessment of the EU 2050 Strategy (European Commission; 2018b), the average annual investments in energy demand (hence, energy efficiency) are larger than the investments in renewable energy. Estimated investment needs for residential energy efficiency were 198.1 bn to 235.1 bn Euro¹³, depending on the scenario (European Commission; 2018b). In 2016 investments in energy efficiency in buildings in Europe according to the IEA (2017) were around 120 bn USD (with the EU share of 30% of global investments in the sector). This means that compared to the more ambitious EU scenario (235.1 bn Euro), energy efficiency investments would have to be around two times the current level. For Germany, this would mean energy efficiency investments of 38 bn Euro per year (or 1.2% of GDP in 2016)¹⁴. If the same ratio of current investments compared to required investments is assumed, Germany would need to increase its investments in energy efficiency in buildings by around 18.5 bn Euro per year. This is roughly in line with BCG and Prognos (2018), which estimate additional investment needs for Germany to be between 13.7 and 19.7 bn Euro (480-690 bn Euro over 35 years) for residential and commercial buildings.

Currently, the “energy-efficient renovation” program of KfW in Germany finances renovations of around 275,000 residential units per year with an investment volume of 10-11 bn Euro, in 2016 and 2017 respectively (IWU and Fraunhofer IFAM; 2018). If renovation rates need to reach at least 2% of buildings, this would amount to 800,000 buildings per year and about 30bn Euro of investment per year. This means that the potential market for energy efficiency investments in buildings is around three times higher than what is currently invested under the KfW program.

In 2016, 727.400 residential property transactions with a value of EUR 155.7 bn were made (about 1.8% of residential building units) (AK OGA; 2017). About 1/3 of the transactions were new constructions and 2/3 were existing buildings. If all of these buildings would be renovated to an energy label A or B, it would mean an additional renovation potential of about 1.2% of existing buildings per year (assuming the same amount of transactions during the coming years and that these buildings have an energy label of C or worse). Banks have an important advisory role when properties are being sold. One possibility is to include a shadow price for carbon emissions in the investment calculation (similar to Scenario 2) to account for the future risk and to offer renovation advice during the loan origination.

¹³ Additional investments are needed for energy efficiency in the tertiary sector (58 bn to 76 bn), for energy efficiency in industry (13.2 bn to 35.6 bn) and for energy supply investments, mainly power grid and power plants (133 bn to 246 bn Euro).

¹⁴ 235 bn EUR investment need at EU level divided by 513 million EU citizens times 83 million in German citizens equals 38bn EUR. This is equal to 1.2% of GDP in 2016 (3144 bn Euro GDP for Germany).

Additionally, banks can assist their clients in handling and managing public renovation grants, offering technical advice and ready made tools. Higher renovation rates lead to a growing market for energy efficiency and renewable energy in buildings, opening up new lending opportunities for banks.

6 Discussion

Like investors and asset managers, banks are increasingly asked to report the climate risk and climate impact of their investment or lending portfolio (e.g. through the Principles of Responsible Banking (UNEP FI; 2018)). Mortgages make up a large part of the balance sheets of banks (approximately 13.8% in the Euro Area and 15.6% in Germany), as much as corporate loans all together. Additionally, buildings are often used as collateral for other corporate loans or bonds as well. Hence, next to equity and corporate bond portfolios, mortgage loan portfolios are an important element in the analysis of climate-related risks and opportunities.

In a first step, this paper shows how to identify potential transition risks for mortgage portfolios, by reviewing climate policies for the building sector in different European countries. Two main risk drivers are identified, an energy price shock and a performance standard for the entire building stock. Assumptions on energy price increases from 6 to 10.5 ct/kWh are in line with estimates for 2030 and are comparable to the highest gas price in Europe today (in Sweden). As a comparison, the introduction of a CO₂ price of 180 Euro would lead to an increase of approximately 4.5 ct/kWh. Such an increase in energy prices would lead to an increase of energy costs of 0.2 - 4.4% (for energy label A-H) of an average household income in Germany. To estimate the effect of a performance standard, renovation costs (lower cost estimate) between 285 and 465 Euro/m² (for energy label D to H) are applied. This leads to a decrease in value for energy-intensive buildings between 18.5% - 30.1% of an average residential unit in Germany. The results should be understood as an exploratory study, as data integrating sustainability and financial metrics for mortgages is still scarce and focused on only a few countries.¹⁵

In a second step, the analysis shows an increase of expected credit loss for a “brown” mortgage portfolio (based on the current distribution of energy labels in Germany) in different transition scenarios. The climate-related credit risk of a “green” mortgage portfolio is much lower, however. Hence, this analysis shows that transition risks can be decreased considerably, if the portfolio is shifted strategically towards more energy-efficient buildings. With the emergence of green mortgage bonds, there is a risk that banks only reclassify buildings with energy label A and B into green buildings, but do not improve the overall portfolio, which would have no influence on investments into energy efficiency. To be in line with climate policy targets, the target share of green buildings (label A and B) for the overall portfolio needs to be at least 40% by 2030 and 100% by 2050. Additionally, if these “green” labelled buildings are refinanced via green mortgage bonds, this might increase the climate-related risk in the (remaining) standard mortgage bonds. This risk can be reduced, if all banks have to report the share on buildings in the different energy classes for the whole mortgage portfolio. This would ensure the comparability of mortgage portfolios of all banks.

Scenario analysis is a valuable tool for banks and investors, who want to develop strategies to mitigate potential climate-related risks and to identify potential business opportunities. It can also be helpful for investor to compare the transition risk of standard mortgage bonds and green mortgage bonds. Banks can set energy-reduction targets and implement measures

¹⁵Only issuers of green mortgage backed securities or green covered bonds (or German “Pfandbrief”) are currently disclosing energy related data.

to reach them. The national target of energy reduction in buildings should be used as target for mortgage portfolios (as already done for some green mortgage bonds). They can disclose their targets and report on their progress regularly as part of their Corporate Social Responsibility (CSR) report and in this way improve their ESG rating. A good ESG rating can provide a positive signal to the growing share of SRI investors. The energy target can be reached through active energy-related management of the mortgage portfolio, such as offering attractive financing packages and technical assistance for renovations to owners of energy-intensive buildings. As renovations are often implemented when a building or flat changes ownership, banks can play an important role in advising clients when buying property, by applying a shadow carbon price (affecting operational costs), offering discount on interest rates for buildings with labels A and B, or even rejecting financing requests for houses above a certain threshold (e.g. label D-H before 2030 and C-H after 2030), if they do not include a plan for energy-efficiency renovations.

Currently, there is a lack of specific loan products for energy efficiency in households. Online loan portals usually have two main loan categories, mortgages loans or consumer loans (for furniture, sport equipment, travels, etc.) but no specific loan categories for energy efficiency or renewable energy products.¹⁶ Banks can assist their customers in identifying the most cost-effective energy improvements for the different segments and offer more tailor-made products. In collaboration with energy providers and contractors, they can offer standardized financing schemes for energy-efficient heating systems such as heat pumps or solar thermal units to households and real estate companies. Active ESG-management can become a business opportunity – in mortgage lending as well as for loans to businesses offering energy efficiency and renewable energy products, materials and services.

7 Conclusion

This paper provides a method of how to identify, assess and manage transition risks (and opportunities) in mortgage portfolios. It complements existing assessments of the financial risk of climate policies, which mainly focus on equity and corporate bonds. A scenario analysis of three different transition scenarios is applied to a “brown” and a “green” mortgage portfolio. Results show that for the “brown” mortgage portfolio, the expected loss can increase substantially, depending on the scenario. This risk can be decreased considerably, when the portfolio is shifted towards more energy-efficient buildings.

The results of this analysis have several important implications. Both, a carbon price and a performance standard, can change the risk profile of energy-efficient vs. energy-intensive buildings. A credible and long-term oriented carbon price can have a substantial impact on the operational costs of a building, which might lead to higher default rates. This income effect can be mitigated by redistributing the revenues back to households. However, it would not automatically lead to higher investments in energy efficiency (especially in the case of rental buildings). Performance standards for existing buildings, on the other hand, influence the value of the building. In this case, the owner has a more direct interest in realising the investment, which can potentially lead to higher investments. This value impact can be mitigated by offering subsidies (e.g. through tax rebates or shorter amortisation period for energy efficiency investments) to reduce the investment costs. To ensure that owners have

¹⁶Car dealers and consumer electronics store offer standard financing packages, e.g. BNP Paribas is the financing partner of the electronics store, Saturn, offering consumer loans for up to 20 months and 15.000 Euro. However, only few energy providers and technology providers offer energy-specific financing options (e.g. for a new heating system. Often if such loans are available, interest rates are equal to or above interest rates for consumer loans and are offered for a maximum of 5-10 years, although such investments have longer payback times. Additionally, many banks require an ownership claim, which leads to additional costs)

sufficient time to plan investments into renovations, such policies need to be introduced timely and with a long-term trajectory, which is especially important for buildings due to the long investment cycles. Banks can play an important role in this process.

Currently, energy performance labels (EPCs) are mandatory when selling or renting a flat or house. However, they are not mandatory for financial transactions that involve buildings. Information regarding the energy efficiency of financed buildings (and related risk management processes) are not reported to shareholders or bond holders. However, with the recent growth of SRI investors and green mortgage bonds, this will become more important. To increase transparency for investors and to improve the pricing of transition risks, climate-related disclosure in mortgage portfolios should be promoted.

This analysis shows how the EU taxonomy for sustainable activities (Technical Expert Group on Sustainable Finance; 2019), currently developed by the European Commission, should be further developed to improve transparency, and to promote investments into energy-efficient buildings. It is important that all banks have to report the energy labels of their entire mortgage portfolio, not only of their green mortgage bonds. This would improve (climate-related) transparency for investors and would prevent banks from simply splitting the portfolio into “green” and “brown” buildings, without changing the overall portfolio. In terms of financial regulation, banks could be required to include a risk premium for energy-intensive buildings (EPC label D-H) in the valuation of buildings and to include a shadow price on carbon emissions into their credit scoring.

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