

Austrian banks' exposure to climate-related transition risk

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Climate change poses several risks to the value of financial assets and to financial stability. In this study, we estimate the exposure of the Austrian banking sector to climate risks that might arise from a disorderly transition to a carbon-neutral economy. To this end, we identify climate policy-relevant sectors (CPRSs), i.e. sectors which are particularly sensitive to these transition risks, and match that information with granular data of outstanding credits and bonds held by Austrian banks. We find that the Austrian banking sector's direct exposure to CPRSs is comparable with banks' exposure in other countries and relevant to financial supervision. As some banks are particularly exposed to climate transition risk, both banks and supervisors should take this risk seriously and monitor it closely.

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ECB President Christine Lagarde (2020) acknowledged in February this year that climate change constitutes a major challenge to both the economy and the financial sector. She also announced that, in its financial and monetary analyses, the Euro-system will pay greater attention to climate-related risks. In many euro area jurisdictions, central banks are tasked with safeguarding financial stability. Analyzing the implications of climate change on financial markets and macroeconomic stability is a prerequisite for delivering on this mandate.

Like in most continental European countries, in Austria, banks are a major source of funding for the real economy, with bank loans to nonfinancial corporations amounting to more than 40% of GDP. The effects of climate change can significantly diminish the value of financial assets, which would jeopardize the health of financial intermediaries holding these assets. If risks from climate change are not assessed correctly, financing decisions are based on incomplete information and the expected risk-adjusted return on investment will be systematically biased. Banks are legally obliged to adequately assess, measure and manage credit risks and liquidity risks. As we will show, these types of risks can be triggered by climate change; hence, they should be within the perimeter of banks' risk management. But survey results² show that many banks in Austria and other European countries have not yet implemented appropriate risk identification and risk management procedures.

Overcoming the negative consequences of climate change by transitioning to a carbon-neutral economy requires substantial investments. To this end, the EU has set ambitious climate targets for 2030: (1) cutting greenhouse gas (GHG) emissions

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² See e.g. Bourtenbourg et al. (2019) and Pointner and Ritzberger-Grünwald (2019).

(from 1990 levels) by at least 40%, (2) increasing the share of renewable energy to at least 32%, and (3) significantly improving energy efficiency. The European Commission (2020) estimates that it will take additional investments of EUR 260 billion per year to reach these targets by 2030. One way to mobilize additional funds is to adequately price climate-related financial risks. This disincentivizes investments in climate-damaging, or gray, assets and makes climate-friendly investments in green assets more attractive.

The rest of this article is structured as follows: section 1 defines the financial risks induced by climate change and explains which risk exposure we will focus on in our analysis. In section 2, we present the bank exposure data that are used for the analysis. Section 3 describes the methodology we apply to classify the exposure of banks' loans and bonds to climate policy-relevant sectors. In section 4, we present the results and findings of the analysis and, finally, section 5 concludes.

1 The financial risks of climate change

The financial and economic effects of climate change are classified as physical and transition risks. Physical risks emanate from climate change directly, while transition risks arise from the response – by policymakers, innovators or consumers – to prevent and/or combat climate change. In our analysis, we focus on banks' exposure to transition risk. Nevertheless, we will briefly explain all risk sources as they are interdependent and transition risks are often triggered by concerns about physical risks.

1.1 Climate physical risks

Physical risks refer to the effects of both rising temperatures and extreme weather events, which are becoming ever more frequent. They can be broken down into acute and chronic risks: acute risks are sudden short and severe events that have a significant negative impact, e.g. heavy rainfall causing a flood. Chronic risks reflect continuously deteriorating ecological conditions, e.g. rising sea levels. Physical risks, which can damage material infrastructure and fixed investments, tend to vary from region to region, affecting, for instance, coastal areas differently than glacier regions.

Climate-related physical risks fall into more traditional categories in financial risk management. Once physical risks materialize, they can destroy assets either immediately or gradually, namely by causing the depreciation rate of capital to accelerate through decay or corrosion. If the affected assets have been pledged as collateral for a loan, the loan originator's credit risk rises. Many physical risks are spatially correlated: if, for example, severe flooding destroys a significant proportion of real estate collateral in a particular area, lenders in that region might face higher concentration risk³. If priced in accordingly, the rising uncertainty due to climate change might also lead to higher risk premiums on interest rates, which, in turn, increases market risk.

1.2 Climate transition risks

To mitigate the effects of climate change, it is essential to foster the transition from our current modes of production to a climate-friendly economy. The so-called carbon budget is limited, which means that we are only allowed a specific amount of CO₂ emissions to ensure compliance with the Paris Agreement objective of

³ For more information on how climate-induced disasters relate to banks' lending decisions, see Faiella and Natoli (2018).

keeping the temperature increase well below 2°C in comparison with pre-industrial times (IPCC, 2018). Implementing the low-carbon transition will require targeted climate policies (e.g. carbon taxes), changes in laws and regulations as well as technical innovation and changes in consumers' preferences. However, if the transition is disorderly because climate policies are introduced too late and/or in an uncoordinated way across countries and their impact cannot be fully anticipated by investors, new sources of financial risks could manifest themselves. A disorderly transition could give rise to asset price volatility (both negative for high-carbon activities and positive for low-carbon activities) with implications for financial instability if large and correlated asset classes are involved (Monasterolo et al., 2017).

Regulatory changes can alter the relative prices of low-carbon and gray modes of production. Policies that are effectively internalizing negative climate externalities include carbon pricing and emissions trading schemes and impose a price on emitting GHGs. While the EU's emissions trading system (ETS) covers most power plants and much of the manufacturing sector, emissions from private consumption are subject to national taxation.

The current Austrian government program envisages the drawing-up of an implementation path for measures meant to reflect the true costs of carbon emissions by 2022. This could include the introduction of carbon taxes. With a view to avoiding carbon leakage, the European Commission (2019) also proposed a carbon border adjustment mechanism in its European Green Deal, which would work like a tariff on GHG-intensive imports. Imposing a positive price on GHG emissions reduces the revenues from the underlying economic activities, thereby lowering the emitters' debt-servicing capacity; shares and bonds of GHG-emitting companies will be discounted accordingly.

Further, the diffusion of climate-neutral technologies can act as a tipping point for markets and transform previously valuable gray investments into stranded assets.⁴ Technological innovation can reduce the costs of renewable energy sources and make the latter more competitive vis-à-vis fossil fuels, which are a major source of GHG emissions. On the other hand, oil companies accounting for unextracted reserves in their balance sheets face significant downside risks regarding those assets' future prices in case of technological breakthroughs, as such reserves might turn into stranded assets. The accelerated diffusion of low-cost solar panels or e-mobility devices has disruptive potential, namely by crowding out traditional GHG-emitting machines.

Finally, rising awareness of global warming might change consumer preferences and thus reduce demand for carbon-intensive goods. Such preference shocks can likewise turn high-yielding assets into stranded assets in a short amount of time. A severe devaluation of carbon-based assets and lower revenues for debtors due to demand shifts mean that banks face a higher probability of default on some of their loans.

A report by the ESRB (2016) recognized that, despite the well-established need for the transition, there is still great uncertainty regarding its pace. Depending on the timing of behavioral changes by governments, companies and consumers, the transition could result in a "soft landing" or a "hard landing." The latter would yield

⁴ See van Ginkel et al. (2020) on climate change-induced socio-economic tipping points. Vermeulen et al. (2018) also include a disruptive energy innovation in their climate stress test for the Dutch financial system.

a “too late, too sudden” scenario: systemic risk would increase because of stranded assets at a time when more and more physical risks are likely to materialize.

Our analysis focuses on transition risks of climate change only. This is due to the data available and should not be read as a prioritization of transition risks over physical risks. For a proper analysis of physical risks, we would need geographical data on where assets are located, and such data would then have to be matched with location-specific vulnerabilities to climate hazards like flooding or storms, as shown in Faiella and Natoli (2018). As we currently have no access to such data, we concentrate on transition risks.

2 Data description

To quantify financial risks stemming from climate-related (physical, transition) risks, it is key to have reliable data on financial firms' exposure to nonfinancial companies. Obtaining a comprehensive dataset to analyze banks' assets regarding their transition or physical risk continues to be challenging as banks' asset types and the structure of their loan portfolios are more diverse. The supervisory reporting framework was designed for assessing banks' resilience against various financial risks. Risks specifically associated with climate change have not yet been incorporated. This is also true for financial reporting, which likewise lacks detailed reporting standards geared toward quantifying climate risk.

Here, we combine granular supervisory reporting data of banks with a detailed methodology on identifying climate policy-relevant sectors (CPRSs) to assess banks' exposure to potentially vulnerable assets. Current financial reporting in Austria allows us to analyze banks' balance sheet structure on a very granular basis. Since 2019, all banks incorporated in Austria have been reporting loan data at the level of individual instruments. These data reported to the OeNB cover loans above the following thresholds: EUR 25,000 for legal entities and EUR 350,000 for individual persons. Together with individual data on other exposure types, such as securities, equity and off-balance sheet items, the granular credit data contain exposures of Austrian banks worth EUR 946 billion at year-end 2019, which represents about 85% of Austrian banks' total exposure at the unconsolidated level.⁵ For our analysis, we use bank exposure data which refer to year-end 2019 and contain information on the originating bank, borrower characteristics, instrument types and exposure volume.⁶

As the data are collected for Austrian banks at the unconsolidated level, they only include exposures recorded in Austria. They include direct foreign exposures but exclude foreign subsidiaries. Another caveat is the lack of information on the designated use by the borrower of the funds provided. Such information would help assess climate policy relevance and the associated transition risk.

During the process, we added data from other sources to compensate for shortcomings in certain aspects. For securities, we included market data⁷ on “green

⁵ For better readability, we refer to all aforementioned exposure classes as assets or bank claims, which include certain off-balance sheet positions (e.g. committed credit lines).

⁶ The following attributes are used in the analysis: “BankID,” “borrower LEI (i.e. legal entity identifier) code,” “borrower OeNB ID,” “borrower description,” “borrower region,” “NACE 4 digit,” “type of instruments” and “total exposure amount.”

⁷ Data on green and sustainable bonds in the bond portfolio of Austrian banks were derived from Bloomberg, Wiener Börse, Nasdaq SWE, Börse Frankfurt, Euronext, Borsa Italiana, Luxembourg Green Exchange, ICMA GBP and CBI LGX.

bonds” issued by nonfinancial corporations with a view to flagging bonds that are supposed to be positively affected with regard to transition or physical risk. Since the utility sector is a key CPRS, we include information from financial and sustainability reports of power producers to differentiate between renewable and nonrenewable forms of energy production.

The most important link between the OeNB’s granular credit dataset and the CPRS database are borrowers’ 4-digit NACE codes classifying economic activities at a granular level. Therefore, we removed the data points for which this attribute was missing as we were not able to map such loans according to their designated use (1.9% of all credit data, amounting to EUR 199 million or 0.2% of the total exposure). Furthermore, we dropped nonbank financial institutions, such as development and leasing companies (1.4% of all cases or EUR 53 billion equaling 5.6% of total exposure) and bank branches from non-Austrian banks (0.7% of all cases or EUR 25 billion equaling 2.7% of total exposure). After these deductions, the remaining exposure amounts to EUR 864 billion.

3 Identification of climate policy-relevant sectors

We follow Battiston et al. (2017) in classifying economic activities into climate policy-relevant sectors. These are defined as economic activities that could be affected positively or negatively (including being transformed into “stranded assets”) in a disorderly transition, i.e. they are relevant for assessing climate transition risk. CPRSs allow to assess the economic and financial risk when firms and sectors are (mis)aligned with the climate and decarbonization targets specified in the Paris Agreement or with other defined policy objectives. The CPRS methodology was used by the European Insurance and Occupation Pension Authority (EIOPA, 2018) in its Financial Stability Report to assess the climate risk exposure of the European insurance sector and by the ECB (2019) in its Financial Stability Review to assess the exposure of euro area investors to economic activities that are considered climate policy relevant.

CPRSs have been identified by using the following criteria: (1) their direct and indirect contribution to GHG emissions; (2) their relevance for climate policy implementation (i.e. their cost sensitivity to climate policy or regulatory change, e.g. the Carbon Leakage Regulation⁸); (3) their role in the energy value chain.

Starting from the NACE sector classification, the above criteria yield 6 main climate-policy relevant sectors: fossil fuels, utilities, energy-intensive, buildings, transportation, agriculture. Then, by increasing the granularity of some sectors (e.g. fossil fuels/coal, fossil fuels/oil, fossil fuels/gas), we obtain about 20 subsectors related to the main types of different technologies that are relevant for the energy transition. The NACE classification does not offer a sufficiently granular breakdown to distinguish between these technologies. Nevertheless, it can be complemented in order to identify industry-level or even firm-level sources of transition risk. For instance, the shares of power generation from different energy sources (e.g. coal, gas, wind, solar) can be obtained at the level of individual utility companies and used to estimate how the net effect of the transition shock plays out across the business lines of the company. This allows to add a climate risk connotation to the NACE

⁸ This regulation provides a list of sectors and subsectors which are deemed to be exposed to a significant risk of carbon leakage, e.g. manufacturing of cement or basic iron and steel.

Table 1

Climate policy-relevant sectors: definition and classification

	Role in greenhouse gas emissions	Transition risk	NACE (4-digit codes)
CPRS			
Fossil fuels	Production of primary energy based on fossil fuel; indirectly responsible for GHG emissions from fossil fuels	Revenues primarily from fossil fuels (e.g. extraction, refinement); diversification/use of different resources not possible	Extraction of coal, gas and oil (e.g. 05.20), manufacturing related to the refinement of coal, gas and oil (e.g. 19.10) electricity and gas (e.g. 35.21), retail sales of automotive fuels (e.g. 47.30)
Utilities	Production of secondary energy; responsible for GHG emissions relative to type of fuel used	Revenues from generation, transmission or distribution of electricity; diversification possible (e.g. solar, wind)	Electricity production (e.g. 35.11)
Energy-intensive	Activities with intensive energy use as input	Affected by price changes of energy or restrictions on use of GHG-intensive sources	Mining and quarrying (e.g. 07.10), various manufacturing sectors (e.g. 11.01, 13.10, 23.51) based on the EU carbon leakage list
Transportation	Provision of and support for transportation services	Fossil fuel-intensive, but no strict dependence on GHG emissions; diversification possible	Manufacturing of motor vehicles, ships and trains (e.g. 29.10), construction of roadways (e.g. 42.11), sale of vehicles (e.g. 45.32), transportation (e.g. 49.10)
Buildings	Provision of building services from construction to renting	Energy-intensive, but diversification possible	Residential and commercial construction (e.g. 41.10), accommodation (e.g. 55.10), real estate (e.g. 68.20)
Agriculture	Agriculture, forestry and related services	Energy-intensive, but diversification possible	Agriculture, forestry and fishery (e.g. 1.10)

Source: NACE, authors' compilation.

4-digit sector classification that per se does not provide any proxy of climate risk or does not carry any information on the technology mix or on the relevance for climate policy implementation. As such, the CPRS classification overcomes the limits of a classification based purely on GHG emissions and NACE 4-digit sectors.

To identify the exposure to transition shocks, these 6 main sectors and 20+ sub-sectors need to be mapped to sectors and technologies whose output evolution is described by forward-looking economic models that take into account future climate policies, such as the scenarios provided by integrated assessment models (IAMs).

Recently, the European Commission's Joint Research Centre (JCR) used the CPRS methodology to assess the climate transition risk exposure of the sectors included in the EC green taxonomy (Alessi et al., 2019). While building on the NACE code classification, the EU taxonomy recognizes that in several cases a more granular classification by technology is required to identify economic activities that can be considered sustainable.

4 Empirical results

In this section, we present our results on Austrian banks' exposure to climate transition risk as broken down by CPRSs. Using the granular credit data described above, we now take a deep dive into the allocation of bank claims to climate-relevant sectors and thus their exposure to climate-related transition risk. Note that in this analysis we aim to measure the exposure subject to transition risk, but do not quantify any impact resulting from potential sectoral losses or revaluation.

Chart 1 represents the Austrian credit data aggregated into the six CPRSs fossil fuels, utilities, energy-intensive, buildings, transportation and agriculture. Assets not falling into these sectors are grouped in the “other” category. In total, Austrian banks hold CPRS assets worth EUR 228 billion. In other words, about 26% of Austrian banks' financing is exposed to climate transition risks that may result from disorderly changes in climate policies, technological breakthroughs or preference shocks.

At EUR 142 billion (or 16%), the biggest part of Austrian banks' climate-relevant claims is mapped to the buildings

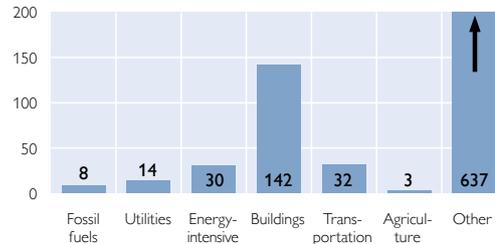
category. This category spans a broad range of economic sectors, e.g. all activities associated with construction, manufacturing of furniture, accommodation and real estate activities. These activities carry rather heterogeneous risks, which differ in the probability of occurrence and their impact on affected firms' debt servicing capacity. However, the majority of bank claims on this sector comes from renting and operating real estate, an economic activity that is exposed to transition risk. If, for example, new regulations on energy efficiency are introduced, firms in this sector face high investment cost and potentially also some write-downs for buildings that cannot be adjusted to meet the new requirements. Such firms' investment needs may also increase substantially as demand changes due to preference shifts with respect to heating systems. In Austria, the contribution of the renting and operating real estate subsector to total value added is significantly above the euro area average because more people in Austria rent, rather than own, a home.⁹

The other five CPRSs with a comparatively high exposure to climate policies make up around EUR 86 billion (or 10%) of assets. The residual “other” category, which runs to EUR 637 billion (74%), is composed of non-climate-relevant economic sectors, such as administrative activities, communication, education or finance. The finance sector within the “other” category also includes interbank and central bank claims amounting to EUR 305 billion, which we kept in the analysis to reflect the entire assets structure. Note that in our analysis we only consider banks' direct risk exposure to nonfinancial corporations in the CPRSs, while factoring out indirect exposures resulting from interbank credits to banks that are exposed to these corporations. Given the comparatively low exposure of the entire banking sector, the indirect effects are assumed to be rather mild, too.

Chart 1

Austrian bank assets aggregated to climate policy-relevant sectors (CPRSs)

Assets in EUR billion



Source: OeNB.

Note: Assets from all remaining non-climate-relevant sectors are aggregated in the “other” group. The latter includes assets from, for instance, administrative activities, education, finance and health services. For better visualization, the y axis is truncated at EUR 200 billion.

⁹ According to the 2017 wave of the Household Finance and Consumption Survey, only 45.9% of Austrian households lived in owner-occupied housing; for the euro area as a whole the share was 60.3% (see table A1 in ECB, 2020).

Austrian banks' exposure to energy production

The utilities sector is of special importance as it includes claims on both energy production and supply companies. We have analyzed publicly available information (e.g. annual and sustainability reports) of about 200 relevant energy producers within the utilities CPRS.¹⁰ From these additional data, we were able to extract valuable information on Austrian banks' lending structure in this sector as illustrated in chart 2.

The information we collected corresponds to an exposure volume of EUR 7.6 billion, which represents about 80% of Austrian banks' exposure to energy production. We used this information to identify which energy sources producers supply, whether they provide renewable energy sources and if they issue a sustainability report with standardized information on climate intensity.

Of the EUR 9.3 billion total claims on energy-producing companies, approximately EUR 5 billion (53.5%) benefit companies that produce nearly 100% renewable energy across different energy types, and EUR 4.3 billion (46.5%) are either claims on nonrenewable energy companies or companies that could not be classified. This result is mostly consistent with the structure of energy production in Austria, where 76.6% of the average Austrian energy mix is based on renewable energy sources (E-Control, 2019). 53.5% of claims on energy-producing companies relate to Austrian companies while 46.5% is invested in foreign companies either via direct loans or bonds. Austrian firms' exposure is evenly split among small, medium-sized and large banks. In contrast, the foreign part is held predominantly by a few large banks or special purpose banks.

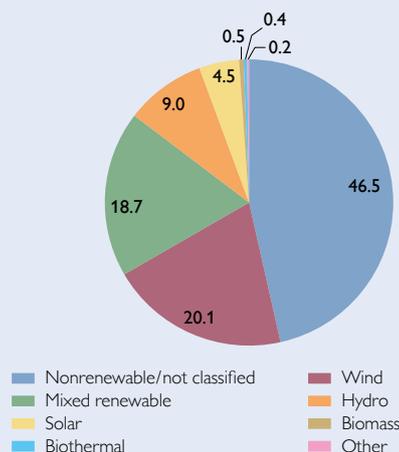
It is interesting to note the distribution of assets across the different energy types when compared to the actual energy mix. 20.1% of Austrian banks' assets are composed of wind power producers, 18.7% of mixed renewable energy producers and only 9% of hydroelectric producers. This is in stark contrast to the actual energy mix, which consists of 59% hydropower and only 9.16% of wind power. There are two possible explanations for this phenomenon. First, the levelized cost of electricity (LCOE) for constructing new power plants per kilowatt hour is higher for onshore (and offshore) wind parks than for hydropower plants (PowerTech, 2015). This could increase wind energy producers' financing needs that would be reflected in the granular credit data. Second, many hydropower plants in Austria were built decades ago (Hydropower, 2018) and are thus not represented on banks' balance sheets.

In a next step, we disentangle the distribution of bank claims on CPRSs according to different bank characteristics. We first consider banks' size in terms of total assets (chart 3, left panel) by dividing banks into three groups: small banks (total assets

Chart 2

Austrian banks' exposure vis-à-vis types of energy production

% of total energy production in the "utilities" sector



Source: OeNB.

Note: Companies that produce renewable energy and cannot be allocated to one specific energy type were placed in the category "mixed renewable."

¹⁰ We individually assessed power producers that are funded by Austrian banks via loans or bonds with a volume of more than EUR 10 million.

below EUR 5 billion), medium-sized banks (total assets between EUR 5 billion and EUR 30 billion) and large banks (total assets above EUR 30 billion). Thus, small and medium-sized banks in a way represent the less significant institutions (LSIs), while large banks represent the majority of significant institutions (SIs) under direct supervision of the ECB.¹¹ Small banks account for 94.7% of all banks under consideration and 30.1% of total assets; medium-sized banks account for 4.3% of all banks and 31.5% of total assets and large banks make up 1% of all banks and hold 38.4% of total assets. Medium-sized banks on average have a higher exposure to CPRSs (31.1%) than smaller banks (25.6%) and larger banks (23.3%). Nevertheless, the mix of CPRSs differs across the groups. The small and medium-sized banks hold the majority of their assets in the buildings category (roughly 20% each). But there are also differences between the two groups: while small banks' exposure to the agriculture portfolio is greater (0.8%), medium-sized banks' energy-intensive portfolio is larger (2.8%). Large banks, by contrast, are most exposed to fossil fuels (1.9%), utilities (1.9%) and the energy-intensive sector (5.6%). The clustering of the fossil fuel exposure with large banks could be explained by the respective corporations' sizable financing needs. Indeed, at EUR 5.3 million, the average exposure to fossil fuels is the largest across all six CPRSs. Furthermore, 73% of these fossil fuel assets are located outside Austria, which also represents the largest non-Austrian exposure share across the sectors. This implies that many smaller regional banks would not be able to meet the financing demand by the fossil fuel industry.

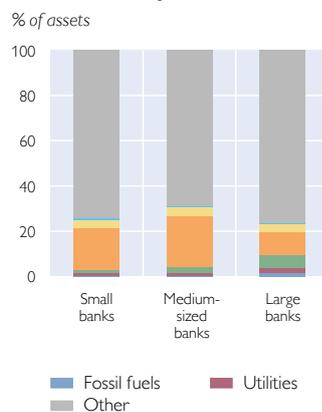
Breaking down Austrian banks by their business models provides a more detailed insight into banks' exposure to climate transition risk via CPRSs. We differentiate between banks with a single-tier structure and banks belonging to multi-tier sectors. The former comprise building and loan associations, joint stock banks, state mortgage banks and special purpose banks. In contrast, the two-tier sector banks refer to Volksbank credit cooperatives and savings banks, while Raiffeisen credit cooperatives make up a three-tier sector. Different business models result in very heterogeneous financing portfolios (chart 3, right panel). Overall, the buildings sector is the dominant asset class across all banking sectors. Special purpose banks are an exception, with their total share of CPRS claims amounting to a mere 11.4%, of which 10.1% fall into the transportation category. After all, five out of fifteen special purpose banks exclusively finance motor vehicles. At 40.2%, state mortgage banks record the largest exposure to CPRSs. Although they are set up as regional universal banks with both corporate and retail customers, their core business includes residential property and public-sector lending, which is partly reflected in their 34.7% share of the broadly defined buildings sector. Joint stock banks display the highest exposure to the sectors fossil fuels (1.6%), utilities (2.5%) and energy-intensive (5%). With joint stock banks, the distribution of assets is very similar to that recorded by large banks.

Next, we explore whether there are regional differences in banks' CPRS exposure based on their geographical location. As the many small, locally operating banks help meet the financing needs of the respective local economy in the municipalities

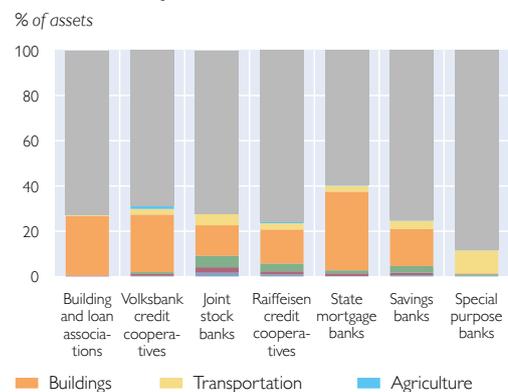
¹¹ The group of large banks include BAWAG P.S.K., Erste Group Bank AG, Raiffeisen Bank International AG, Raiffeisenlandesbank Oberösterreich Aktiengesellschaft and UniCredit Bank Austria AG. The remaining SIs, Volksbank Wien AG, Sberbank Europe AG and Addiko Bank are subsumed under the medium-sized and small groups, respectively, as the total assets of both unconsolidated entities are below EUR 30 billion each.

Austrian banks' CPRS assets by bank size and bank sector

CPRS assets by bank size



CPRS assets by bank sector



Source: OeNB.

Note: Bank size is defined in terms of banks' total assets: small banks: up to EUR 5 billion; medium-sized banks: from EUR 5 billion to EUR 30 billion; large banks: over EUR 30 billion.

and provinces¹², we would expect to see that behavior reflected in the exposure to different CPRSs. In the left panel of chart 4, we observe four clusters. First, the lowest total exposure (22.3%) is recorded by banks in the municipality of Vienna. However, it also contains the highest exposure overall to fossil fuels (1.6%) and utilities (1.9%), which can be explained by the concentration in Vienna of larger, internationally active banks that provide financial services to industrial enterprises on a larger scale. The second cluster, which is composed of banks in the provinces of Carinthia and Vorarlberg, shows an average exposure of 27.5%. The third cluster comprises banks in Burgenland, Styria and Upper Austria registering an exposure of 29.9%. Overall, Upper Austria accounts for the largest exposure (4.8%) to the energy-intensive CPRS. Fourth, the CPRS exposure of banks based in Lower Austria, Salzburg and Tyrol runs to 32.7%.

Finally, we break down the credit data by three categories of lending instruments,¹³ namely loans, bonds and other instruments. Bonds issued by nonfinancial corporations make up roughly EUR 95 billion or 11% of the financing extended by Austrian banks. This category is the least exposed to climate-sensitive sectors (see chart 4, right panel), with the transportation sector reflecting the largest share (at 2.2%) of the CPRS portfolio.

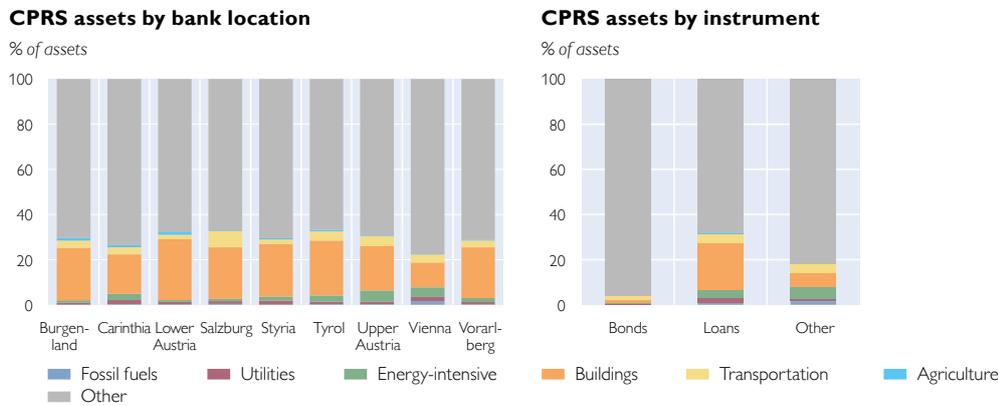
We are interested in analyzing the share of green bonds in the EUR 95 billion total bonds value. Using the bonds' ISIN codes available from the granular credit data, we compare the bonds with different stock exchanges for green, social and sustainable securities. As a result, a total of EUR 2 billion or 2.15% of all outstanding bonds in Austrian banks' portfolios can be classified as green based on the criteria of at least one of the stock exchanges mentioned in section 2. This is consistent with the European average; according to the ESRB (2020), the share of private

¹² Austria is divided into nine provinces: Burgenland, Carinthia, Lower Austria, Salzburg, Styria, Tyrol, Upper Austria, Vienna, and Vorarlberg.

¹³ The "other category" consists of residual bank exposures, such as forward deposits (67.5%) and equity shares (31.1%).

Chart 4

Austrian banks' CPRS assets by bank location and instrument



sector green bonds in the corporate EU bond market amounted to 2% in 2019. We do not see any form of significant clustering of green bonds across any bank characteristics. The majority of lending facilities for the real economy are loans amounting to EUR 621 billion or 71.8%, 31.8% of which are exposed to CPRSs. The assets in the “other instruments” category amount to EUR 149 billion, of which 18.1% are exposed to CPRSs. This is also the category with the highest relative exposure to fossil fuels (1.5%) and the energy-intensive sector (5.4%).

To sum up, 26% (or EUR 228 billion) of Austrian banks' assets are exposed to climate transition risk via the CPRSs. The literature on the banking sector's exposure to climate transition risk is poor due to the difficulties in accessing granular data on the composition of banks' credit and bond holdings, data which result from granular credit data reporting. Weyzig et al. (2014) analyzed the total value of all outstanding corporate loans extended by the 20 largest European banks to high-carbon companies as at December 31, 2012. The authors found that these banks held a weighted average of 7% of their portfolios vis-à-vis producers of oil, gas and coal. This represents a significantly higher exposure when compared with Austrian banks' 0.9% exposure to the fossil fuel category. Battiston et al. (2017), who introduced the CPRSs, focused on the equity portfolios of different financial actors. Although their findings for European banks' holdings cannot be compared with our study at face value, the investment pattern across the CPRSs is similar to our results. An analysis of climate transition risk in the Dutch financial system quantified the exposure of the banking sector to carbon-intensive industries at 13% of all assets (Vermeulen et al., 2018, p. 48). It should be noted that our definition of CPRSs comprises more economic activities than just carbon-intensive industries and is not only based on GHG emission criteria. As such, our analysis allows a mapping with the activities covered by the EU taxonomy (Alessi et al., 2019). In a recent study, Roncoroni et al. (2019) apply the CPRS methodology to the Mexican banking sector and also find low asset values and distribution patterns across the CPRSs (fossil fuels: 3.6%, utilities: 1%, energy-intensive: 3.5%).

Interestingly, when we single out the top 10% banks with the highest share of CPRS claims in our sample, the average exposure to climate risk of these banks

reaches 42%, which is mainly due to a more than twofold increase of the exposure to the buildings sector. Certain banks therefore face heightened risk from a possible change in climate policies, technological breakthroughs or preference shocks. It is thus imperative that banks monitor and assess their climate risks adequately and follow the guidance provided by supervisory authorities (e.g. FMA, 2020).

5 Summary and conclusions

Our analysis combines granular supervisory data on banks' exposure with a methodology to identify economic sectors that are relevant for climate transition risk, i.e. climate policy-relevant sectors (CPRSs). We descriptively analyzed Austrian banks' exposure with respect to their climate policy-relevant assets by using detailed credit data reported by banks. In addition, we wanted to highlight the strengths and limitations inherent in the current supervisory reporting framework when it comes to supporting such an analysis.

We considered the CPRS methodology by Battiston et al. (2017) and Battiston and Monasterolo (2019) to make a top-down assessment of the climate policy relevance of the Austrian banking system's portfolio. Our results show that 26% of the analyzed assets of Austrian banks are held vis-à-vis CPRSs and thus exposed to climate transition risk. Thereof, 16% relate to the buildings sector, which by definition spans a wide array of economic activities that are likely to be heterogeneously affected by transition risk. Another 10% of assets relate to fossil fuels, utilities, energy-intensive, transportation and agriculture sectors.

A disorderly transition to a low-carbon economy would affect the Austrian banking sector via this exposure. We find that the sector's direct exposure to most CPRSs is comparable with banks' exposure in other countries and relevant to financial supervision. Further, the overall shock on individual institutions will also depend on their financial characteristics and risk factors, including leverage (Monasterolo et al., 2018). It should be noted that despite the resilience of the system as a whole, some individual banks exhibit significantly larger exposures and accordingly face a higher risk, which should be appropriately assessed, measured and managed. Guidelines for the proper treatment of such risks can be found in the guide on sustainability risks recently published by the Austrian Financial Market Authority (FMA, 2020).

Analyzing the distribution in certain banking sectors, we notice that larger banks have a higher exposure to fossil fuel and energy-intensive sectors than small or medium-sized banks. Additionally, the regional distribution of bank claims reflects the economic profile of the nine Austrian provinces. At the instrument level, exposure to CPRSs is mainly driven by loans and other instruments, while bonds account for a relatively small share.

Value is added to the analysis by examining individual assets in greater detail. To this end, we used firms' reporting data, including their sustainability disclosure. The utilities sector in particular is composed of mixed firms, i.e. firms that have both a renewable and fossil fuel-based business. A large share of Austrian utility companies produces electricity by using renewable energy sources, which needs to be reflected in any top-down analysis.

Classifying banks' balance sheets according to the CPRS methodology helps determine strengths and vulnerabilities of the Austrian banking sector regarding climate transition risk. Our analysis points to persistent data limitations hampering

a detailed analysis. The fractured nature of the loan portfolios consisting of small corporate loans renders an in-depth analysis difficult. Two things would improve transparency and help banks and supervisors alike to assess and price in climate risk exposure in banks' balance sheets: first, standardized information on climate risks in financial reporting and, second, better disclosure of the energy technologies used and of the emission intensity of projects financed by loans.

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