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Banks and Environmental Sustainability: Some reflections from the perspective of financial stability

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Key points for policy-makers

There is growing evidence suggesting that climate change risks have important implications for financial stability, although the analysis of the complexity of the potential risks to the financial sector is still at an early stage. This Policy Brief quantifies the direct (syndicated) loan exposure to elevated environmental risk sectors of the largest banks in the EU, Switzerland, the US, Japan and China on average at between 0.3 to 3.7% of total banking assets and €1.35 trillion in total as of December 2014.

Policy recommendations

The policy recommendations operationalise the 2016 recommendations on climate-related issues issued by the Enhanced Disclosure Task Force (EDTF) to G20 countries and advise revising the banks´ prudential policy to consider environmental risks.

- Better understanding the direct exposure to high environmental risk sectors demands a reliable and harmonised statistical framework that allows for detailed identification of sectors exposed to high environmental risks along the SIC (and NACE in the EEA) classifications.
- Develop credit registers to become a tool that facilitates the assessment of environmental risk drivers in 'carbon stress tests'.
- Environmental aspects should be considered in the revisions of the assessment methodology of the Basel Core Principles for Effective Bank Supervision.

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Introduction

Financial policy and regulation are increasingly recognised as important dimensions of the transition towards a low carbon economy, which is consistent with the full implementation of the Paris Agreement.[1] There is a growing recognition that the inculcation of green guidelines and standards into bank lending, trading and investment practices are critical for achieving the core mandates of international financial organisations, such as the International Monetary Fund and the World Bank. Economic growth and financial development should aim to be economically, socially and environmentally sustainable. Furthermore, it is widely accepted that low-income developing countries (LIDCs) are especially vulnerable to the projected effects of climate change and will need significant assistance in the form of concessional climate finance to support adaptation efforts. The impact of the transition on financial stability depends primarily on the speed and the smoothness of the transition to a green economy and adjustment costs.[2]

Against this backdrop, this Policy Brief explores potential prudential policy responses that could contribute to internalising the negative externalities associated with climate change by both banks and their prudential supervisors.

1. Scenarios for the transition to low-carbon economy

Controlling climate-change risks requires a decisive shift away from fossil-fuel energy and related physical capital. At the same time, the long-term horizon of the commitment to reduce emissions (2030) and the cost of short-term action reduce the credibility of some existing commitments.[3]

There are two broad scenarios for the transition to a low-carbon economy:

[1] United Nations Framework Convention on Climate Change (see http://unfccc.int/paris_agreement/items/9485.php). Specifically, its objectives were to: i) hold the increase in the global average temperature to well below 2°C above pre-industrial levels and pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change; ii) increase the ability to adapt to the adverse impacts of climate change and foster climate resilience and low greenhouse gas emissions development; and iii) to promote more consistent financial flows towards low greenhouse gas emissions and climate-resilient development" (see http://unfccc.int/files/essential_background/convention/application/pdf/english_paris_agreement.pdf).

[2] See speech given by Mark Carney, Governor of the Bank of England, "Breaking the Tragedy of the Horizon – Climate Change and Financial Stability", at Lloyd's of London, 29 September 2015 (http://www.bankofengland.co.uk/publications/Documents/speeches/2015/speech844.pdf).

[3] As of August 2015, 26 countries and territories accounting for more than 55% of global GHG emissions have submitted Intended National Determined Contributions (INDCs) with a 2030 target year (2025 in the case of the US) (Morgan Stanley, 2015). However, power plants that use combustible organic material, such as oil, coal, or natural gas, can operate for up to 40 years, and investment in alternative energy has been dampened by unexpected changes in its regulation (e.g. retroactive government plans to curb revenues of already operational projects in Bulgaria and Romania and retroactive tariff changes in Germany).

First, a **gradual and smooth transition** to a low-carbon economy that allows adequate time for technological progress to contribute to keeping energy costs at socially acceptable levels and for the physical stocks of carbon-intensive energy sources to be replenished. This would allow the economy to smoothly endogenise changes associated with the transition.

A smooth transition would require significant and realistic investments in infrastructure (e.g. renewable energy), new technologies (e.g. energy storage) and energy efficiency, which will have an overall positive effect on the economy. Bank credit quality and the performance of investment portfolios would be resilient during the transition (Stern, 2008; Acemoglu et al. 2012). Governments could enhance the likelihood of this scenario through, for example, the gradual increase in emissions taxes, quotas and technological standards.

Second, an **abrupt transition** to a low-carbon economy. Although carbon markets encourage reductions of emissions, the market signals for future investment are unclear. Newell et al. (2014) argue that the evolving nature of carbon markets and associated design changes imply that governments cannot provide market certainty, thereby increasing the likelihood this scenario. The consequences of an abrupt transition would be a sharp rise in energy costs; a severing of the energy supply; sudden depreciation of fossil reserves and economic obsolescence of investments and other capital stocks; as well as a downward revaluation of the market value of firms according to their exposure to carbon-intensive resources and technology. This adverse scenario could have a severe impact on banks' exposure via the following transmission channels:

(i) GDP growth could be impaired by the increase in the costs related to the supply chain and/or changes in the demand for products as well as cost of capital;
(ii) Direct exposure to high environmental risk sectors: financial assets whose underlying value depends on the extraction or usage of combustible organic material as oil, coal or natural gas; and
(iii) Second-round effects due to the financial system's indirect exposures to carbon-intensive assets and the global nature of climate change risks.

Companies in high environmental risk sectors are very much debt-financed either by the bond markets or bank loans. Moreover, they have increased their indebtedness since the financial crisis, especially in the US and in emerging economy markets. For example, companies in the oil and gas sectors almost tripled their levels of debt from 2006 to 2014.[4] High leverage will increase the severity of the credit losses and debt repricing in the face of a large fall of these asset prices.

2. Impact of transition on banks

This article focuses on banks' direct exposure to high environmental-risk sectors in the main global banking markets: European Union (EU), Switzerland (CH), the United States (US), Japan (JP) and China (CN). In light of the lack of a clear internationally agreed definition of 'green' vs.

[4] See data in CISnet.com (http://csimarket.com/Industry/industry_Financial_Strength_Ratios.php?ind=107).

'brown' industries, this article considers the exposures to sectors with immediate or emerging elevated exposures as defined by Moody's (2015).

Table 1. Loans to high environmental risk sectors – Main banking markets (€bn, Dec 2014)

Sector	EU	CH	US	JP	CN	Total
Mining: coal	10.4	0.6	6.2	3.4	2.9	23.5
Unregulated utilities and unregulated Power companies	20.7	1.9	17.3	7.6	1.0	48.5
Power generation	166.3	12.2	99.6	65.9	19.4	363.4
Oil and gas: refining and marketing	177.3	17.0	164.0	69.1	11.9	439.3
Building materials	20.0	1.1	8.9	22.0	0.7	52.8
Chemicals-commodity	51.2	5.8	36.4	35.9	6.0	135.4
Steel	18.8	1.9	15.9	12.7	1.7	51.1
Mining-metals and other materials excluding coal	22.5	2.7	16.2	10.2	5.6	57.3
Automobile manufacturers	90.9	5.4	52.0	21.7	7.8	177.8
Total	**578.2**	**48.5**	**416.6**	**248.7**	**57.0**	**1349.0**
% of total assets	*1.4%*	*2.1%*	*3.8%*	*2.1%*	*0.5%*	..

Notes: Exposure is expressed in value terms (€bn), and it is the outcome of extrapolating to the whole national banking sector, the same percentage of the up to 10 largest consolidated banks' (e.g. foreign subsidiaries excluded) exposure to high environmental risk corporate exposures to their total assets. The original values in USD have been converted to EUR based on the 31 December 2014 exchange rate (1 EUR = 1.2141 USD). The bank data are obtained from SNL and ECB (only for European banks) as of year-end 2014. For each loan, the share of one or more of the analysed banks in the provision of the loans issued to high environmental risk sectors was estimated depending on their role as book runner or common participant following the same methodology as Weyzig (2014).

Source: Thomson ONE Banker

Sectors exposed to high environmental risks obtain financing from banks. Table 1 shows the total estimated value of outstanding loans to high environmental risk sectors as of December 2014. In order to assess the exposure of the main banking markets to loans issued to corporates in the above-mentioned high environmental risk sectors, the Thomson ONE financial database for syndicated loans has been used.[5] Similarly to Weyzig (2014), the Thomson ONE financial database on the banks' role as book runners is used for syndicated loans; that is, as the lead arranger who also provides a large share of the actual lending (bilateral loans are considered of marginal relevance). The largest banks from the above-mentioned countries with financial information available in SNL Financial and EU banks with financial information available in the ECB database are used.[6] The comparisons are limited by differences in accounting standards (e.g. IFRS vs. US GAAP).

The total estimated value of the outstanding loan exposures to high environmental risk sectors in the EU, Switzerland, the US, Japan and China account for about €1.35 trillion.[7] The outstanding loan exposures to high environmental risk sectors vary approximately between 0.5% of total assets of Chinese banks, 1.4% for EU banks and 3.8% for US banks. Looking at the individual institutions, the highest exposure of an institution is 8.7% of total assets for a bank in the EU (Podravska Banka). In Switzerland the highest exposure of an individual institution is

[5] Syndicated loans are considered the bulk of the bank financing.

[6] Subsidiaries and branches of banks from foreign countries have been excluded.

[7] By assessing the relative share of the 10 largest (or total reporting if less) banks' high environmental risk loan exposure to each high environmental risk sector in relation to their total assets, these findings can be extrapolated across sectors in the respective country/area (EU, Switzerland, US, Japan and China) to give an indication of the country/area total loan exposure to high environmental risk sectors.

3.4% (Credit Suisse Group AG), US 6.1% (PNC Financial Services Group), Japan 3.7% (Mizuho Financial Group) and China 0.8% (Bank of China Limited).

Overall, approximately 32.5% of the total value of the facilities was provided to companies involved in the exploitation of oil and gas, and 27% of that same value was lent to power generation companies. Automobile manufacturers were recipients of 13.2% of the total estimated value of outstanding loans to high environmental risk sectors. The remainder was financing chemicals, building materials, steel, unregulated utilities and mining (coal and metals).

Table 2. Loans to high environmental risk sectors in selected EU countries – EU (€bn, Dec 2014)

Sector	AT	BE	DE	DK	ES	FR	GR	UK	IE	IT	NL	PT	SE	EU
Mining: coal	0.6	0.1	2.5	-	0.7	2.0	0.3	2.2	-	0.5	1.0	-	0.1	10.4
Unregulated utilities and Unregulated Power companies	0.0	0.1	2.8	0.0	1.6	5.1	-	4.7	0.1	4.8	1.1	0.2	0.2	20.7
Power generation	1.3	3.3	40.3	0.3	14.1	29.5	0.1	49.1	2.4	13.1	7.3	1.8	2.5	166.3
Oil and gas: refining and marketing	2.5	0.7	31.7	0.8	14.1	41.3	0.1	54.5	0.6	8.6	13.7	0.3	7.2	177.3
Building Materials	0.8	0.3	4.2	0.4	3.3	4.0	0.1	3.6	0.2	1.7	0.9	0.1	0.4	20.0
Chemicals-commodity	0.8	0.4	16.8	0.0	2.8	8.4	0.0	13.9	0.6	3.5	2.4	0.7	0.8	51.2
Steel	0.5	0.1	5.8	0.2	1.0	3.6	-	3.8	0.1	1.9	1.3	0.1	0.6	18.8
Mining-metals and other materials excluding coal	0.1	0.2	2.2	0.0	1.5	7.0	-	8.5	-	1.1	1.2	-	0.1	22.5
Automobile manufacturers	3.7	0.2	39.2	0.7	4.4	10.4	0.0	18.1	0.3	9.8	2.6	0.0	1.4	90.9
Total	10.3	5.3	145.5	2.4	43.6	111.2	0.6	158.4	4.3	45.1	31.5	3.2	13.1	578.2

Source: Thomson ONE Banker. Countries not reporting data either to SNL or Thomson ONE Banker: Czech Republic, Estonia, Latvia, Luxembourg, Slovakia and Cyprus. Countries with no exposure to high environmental risk sectors: Finland, Lithuania, Malta, Romania and Slovenia. Other countries not included in the table that report exposures: Bulgaria (€161 mil.); Croatia (€449 mil. power generation) and Hungary (€90 mil. power generation; €259 mil. gas and refining).

The EU shows the largest value of outstanding loans to high environmental risks sectors followed by the US, with approximately 72% of the EU exposure, followed by Japan, China and Switzerland. In the EU, Switzerland, the US and Japan, the largest proportion of high environmental risk corporate loans is concentrated in oil and gas companies, followed by power generation companies. In China, the largest proportion of high environmental risk corporate loans is concentrated in power generation companies, followed by oil and gas companies. Focusing on the EU countries (see Table 2), the UK shows the largest exposures, in particular to the oil and gas sectors, followed by Germany with the largest exposures to power generation, followed closely by the automobile sector. In France, the largest exposure to high environmental risk sectors is to oil and gas, followed by power generation sectors.

The environmental risk assessment of the exposures should go hand in hand with the understanding of the credit risk involved (e.g. credit risk of revolving facilities vs. project finance). The largest value by type of loan corresponds to revolving credit facilities (see Table 3), overdraft facilities and floating rate notes (approximately 60% of the total loan exposure), which provide companies with the option to take up financing from a bank (often a banking syndicate).[8] The value of revolving credit facilities in Table 3 represents total committed amounts not necessarily fully called upon. The typical maturity of revolving facilities is five years and they are often renewed; but many companies renegotiate (interest rates, fees) their revolving credit facility every year. Term loans are next important in terms of value

[8] The maturity mismatch is a particular constraint of financing environmentally friendly projects.

(approximately 35%), followed by bridge loans and working capital and acquisition facilities (approximately 3%), which are usually used for general corporate purposes. Trade finance, which is short term and low credit risk, accounts for approximately 1.2% of the analysed syndicated loans, while high credit risk project finance[9] and senior unsecured long-term debt account for less than 1% of a smaller part of total syndicated loans. In the EU, close to 80% of loans to high-risk carbon assets have remaining maturity within the next five years, which is comparable to Moody's time horizon to assess the impact of environmental risks on credit quality of market-issued rated debt.

Table 3. Loans by type of lending instruments – Main banking markets (€bn, Dec 2014)

Sector	Term Loan, Multi Loan Facility	Revolving and Overdraft Facility, Float rate nts	Project finance	Bridge loan, capital and working capital facilities, acquisition	Trade finance	Long-term debt (mezzanine, sub, boll) performance bonds	Total
Mining: coal	13.3	8.8	-	0.2	1.3	-	23.5
Unregulated utilities and unregulated power companies	13.5	32.8	0.1	1.8	0.3	-	48.5
Power generation	131.4	219.4	1.7	5.3	5.1	0.1	363.0
Oil and gas: refining and marketing	142.9	278.2	-	13.0	4.4	0.1	438.6
Building materials	23.2	26.1	0.0	1.9	0.6	0.0	52.0
Chemicals-commodity	54.1	70.4	-	8.9	0.5	0.1	134.1
Steel	21.3	27.0	-	1.3	1.5	0.0	51.1
Mining-metals and other materials excluding coal	17.3	38.7	-	0.5	0.8	0.0	57.3
Automobile manufacturers	59.8	106.9	-	9.5	1.5	0.1	177.8
Total	476.7	808.1	1.9	42.5	16.0	0.5	1345.7

Note: Other loans not included in the table are construction financing, Islamic financing and construction loans (€3.3bn) mostly to the chemical, building material and oil and gas sectors.

Source: Thomson ONE Banker.

3. Some potential policy measures

The potential risks that climate change could pose to financial stability ask for a systemic approach to identify, assess and manage the risks.[10]

The Financial Stability Board (FSB) led Enhanced Disclosure Task Force (EDTF) already delivered recommendations to the G20 on climate-related financial disclosures adoptable by both financial as well as non-financial organisations in December 2016 (TCFD, 2016). The EDTF recommends that full financial disclosure should be provided in corporations' mainstream or public financial filings with a strong focus on risks and opportunities related to the transition to a lower-carbon economy and that financial disclosure should be designed to solicit useful forward-looking information on financial impacts. In the particular case of banks, this paper

[9] Acknowledging that project finance may involve large risks for the environment, the Equator Principles were established in 2003 to provide banks with voluntary guidance for incorporating environmental and social risks into their assessment of credit and operational risks in large infrastructure investment projects. As a result, many large global banking institutions have mainstreamed environmental governance principles into project finance (see http://www.equator-principles.com/resources/equator_principles_III.pdf).

[10] Regulators have put particular focus on ensuring that connected institutions are sound, adequately capitalised and supervised with effective risk management and disclosure systems incorporating climate risks. Some countries are moving in this direction. It is becoming more common for insurers to conduct regular stress testing and supervisors to specify scenarios including natural disasters. Some countries require additional reserves against possible catastrophe events. Solvency requirements may have capital requirements corresponding to catastrophe risk. Some insurers adjust premiums periodically based on loss experience.

argues that the EDTF recommendations could be articulated via i) improvements in the supervisory reporting with a focus on high environmental risk sectors in the short term and ii) the performance of a 'carbon stress test' as a forward-looking exercise to assess the environmental risks and impact on the transition to a low-carbon economy in the medium term.

Additionally, this paper argues that the modification of other existing international frameworks, such as the guidelines for assessors of the Basel Core Principles for Effective Bank Supervision, should be considered in the medium term

3.1 Short-term policy responses

The short-term policy response heavily relies on better understanding of banks' and other connected financial firms' direct exposures to non-financial firms with immediate and emerging elevated environmental risks and the consequences of a disorderly transition to a low-carbon economy. Better disclosure of bank exposures would facilitate a timely assessment of potential risks to financial stability and promote a "smooth rather than an abrupt transition towards a lower-carbon economy."[11]

A reliable and fully harmonised statistical framework and effective disclosure

Such a statistical framework would allow business, financial institutions, governments and rating agencies to have access to reliable and comparable statistical data. To that end, it is vital that the various categories for classifying economic activities are interpreted uniformly. The NACE Rev 2 and the International Standard Industrial Classification (SIC) frameworks allow for a relatively precise identification of economic activities exposed to risk in the transition to a low-carbon economy.[12]

However, a good statistical classification method is not enough. Effective disclosure requirements are being set up for banks and other financial intermediaries playing a key role in improving governance by improving transparency for investors regarding their involvement in unsustainable economic activity. Institutional investors often question banks´ efforts to mainstream sustainability challenges into their business models as well as into their strategies.[13]

[11] See FSB, "Developing Climate-related Financial Disclosures" (http://www.fsb.org/what-we-do/policy-development/additional-policy-areas/developing-climate-related-financial-disclosures/).

[12] Regulation (EC) No 1893/2006 of the European Parliament and of the Council of 20 December 2006 establishing the statistical classification of economic activities NACE Revision 2 and amending Council Regulation (EEC) No 3037/90 as well as certain EC Regulations on specific statistical domains (OJ L 393, 30.12.2006, p. 1).

[13] Transparency is just one dimension of banks´ good corporate governance. The Basel Committee's Corporate Governance Guidelines for Banks adopted in 2015 include a number of key concepts that are directly aligned with the consideration and management of environmental and social issues, namely: i) a recognition of the impact of banks on the broader setting in which they operate, ii) a recognition of banks' accountability to a broad array of stakeholders, iii) an emphasis on the need for an enhanced risk culture and iv) the call for ethical and responsible behaviour (see https://www.bis.org/bcbs/publ/d328.pdf).

Supervisory reporting and other prudential tools to account for environmental risks

Successful prudential reporting rests on three pillars: i) regular call reports with granular information on economic activities exposed to elevated environmental risks including concentration risks; ii) banks' assessment of their Internal Capital Adequacy Assessment Process (ICAAP) and iii) credit registers regularly requesting granular credit risk data. This section focuses particularly on the experience of the EU and more specifically on the recent set-up put in place in the euro area:

i) Call reports

Call reports to assess the financial condition of banks as well as the sufficiency of their own funds that allow an accurate assessment of environmental risks require information of credit exposure to sectors with immediate and emerging elevated risks associated with the transition to a low carbon economy. Similarly, the reporting of large exposures to individual creditors requires reporting only by sector, which is insufficient to identify large exposures to economic activities at elevated risk in the transition to a green economy.[14] It would require granular information at the level of at least 2 digits in the NACE Rev 2 classification and 4 digits in the SIC Classification, which is in line with what banks generally use internally. For example, in the EU common rule book for the regulatory requirements on own funds,[15]individual banking groups are required to submit harmonised, consolidated and IFRS-consistent quarterly financial statements: FINREP (balance sheet and income statements including the breakdown of loan advances to non-financial firms) and COREP (own funds) do not require detailed information of credit exposure to assess the immediate and emerging elevated risks associated with the transition to a low-carbon economy. Classification by only the 18 sectors is too broad.[16] In COREP, the reporting of large exposures to individual creditors requires reporting also by sector, which, as explained above, is insufficient to identify large exposures to economic activities at risk in the transition to a green economy. The call reports of EU banks would require revision along the lines described above if prudential regulators want to give consideration to environmental risks.

ii) Internal capital adequacy assessment

Banks' assessment of their internal capital adequacy, which is later assessed by their prudential supervisors, allows them to identify material risks and describe their management control. This would include environmental risks. Banks assess their regulatory capital requirements in the

[14] Only exposures to individual creditors and not to groups of related companies.

[15] Commission Implementing Regulation (EU) Nº 680/2014 of 16 April 2014, laying down implementing technical standards with regard to supervisory reporting of institutions according to Regulation (EU) Nº 575/2013 of the EU Parliament and of the Council (L191, OJ 28-6-2014) (http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32014R0680&from=EN), keeping the option for supervisors to ask for a less frequent reporting

[16] Agriculture, forestry and fishing, Mining and quarrying, Manufacturing, Electricity, gas, steam and air conditioning supply, Water supply, Construction, Wholesale and retail trade, Transport and storage, Accommodation and food service activities, Information and communication, Real estate activities, Real estate activities, Administrative and support service activities, Administrative and support service activities, Education, Human health services and social work activities, Arts, entertainment and recreation and Other services.

context of a stress test exercise under two plausible scenarios (baseline and stress). This exercise encompasses business risks associated with the transition to a low-carbon economy under various hypotheses of what impact such a transition could have on GDP growth. For example, at present, in the EU, banks generally do not assess the impact of risks involved in the transition to a low-carbon economy on their loan or bond portfolios. These portfolios are not regularly subject to shock simulations such as a sudden economic obsolescence of capital stocks or revaluation of fossil-fuel reserves, which would help assess the impact of the credit risk on the stressed portfolio in banks' profits and solvency.

iii) Granular credit-risk data

Credit registers regularly collect granular credit-risk data from banks and other credit institutions. These databases are composed of detailed and individual pieces of information about instruments giving rise to credit risk, including classification of counterparties according to their economic activities and subsectors of the economy exposed to elevated environmental risks. Credit registers can also provide important breakdowns and details, such as information on the structure (e.g. project finance) and risk patterns of credit granted by the financial sector (e.g. probabilities of default, impairments, maturity, currency, interest rates). For example, in the euro area, the ECB has launched a credit register called Anacredit, which fulfils these requirements to assess the risks associated with the transition to a low-carbon economy. [17]

3.2 Medium-term policy response

The medium-term policy response relies heavily not only on better governance of banks and other financial institutions but also on an effective prudential regulatory framework, which would take into consideration the importance of the environmental risks.

A) Bank supervisors to consider transition risks

The Basel Core Principles (BCPs) are used as a benchmark for assessing the quality of supervisory systems by the IMF and World Bank and providing a common ground of sound supervisory practices.[18]

A comprehensive approach to an orderly transition to a low-carbon economy would require prudential supervisors of banks to internalise environmental risks in their governance systems and procedures as well as in the banking regulatory framework. Hence, environmental aspects should be included in frameworks for the: governance of bank supervision,[19] definition of

[17] The ECB has the power to impose sanctions on reporting agents that fail to comply with statistical reporting requirements defined or imposed in ECB regulations or decisions. Regulation (EU) 2016/867 of the European Central Bank of 18 May, 2016 on the collection of granular credit and credit risk data (ECB/2016/13) (L144 OJ 1.6.2016) (see http://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0867&from=ES).

[18] See http://www.bis.org/publ/bcbs230.pdf. The BCPs were complemented a few years later by similar codes for the supervision of securities operations (IOSCO) and insurance supervision (IAIS).

[19] For example, licensing criteria, supervisory techniques and tools internal control and audits.

capital adequacy,[20] risk assessment process of banks,[2122] disclosure and transparency requirements[23] and international coordination among prudential supervisors.[24]

Along these lines, it could be argued that the guidelines for assessors of the BCPs should be further revised to require bank supervisors to consider the risk associated with the transition to a low-carbon economy in their supervisory practices, such as stress tests, as well as in the banking regulatory framework.[25]

B) "Carbon stress test" for banks

ESRB (2016) and Schoenmaker & Van Tilburg (2016) argue that prudential regulators could run "carbon stress tests" to assess the impact on banks' capital and profitability of an adverse scenario consisting of a disorderly transition to a low-carbon economy that could affect systemic risk. Large plausible environmental shocks could affect systemic risk via two channels (see also Figure 1):

(i) The impact on GDP as a result of supply and/or demand disruptions caused by the adverse effects of direct environmental hazards (e.g. drought) or severe natural or man-made disasters (e.g. deforestation); regulatory and other policy initiatives that seek to mitigate or prevent said environmental hazards (e.g. carbon taxes) and disruptive technological shocks related to the management of environmental risks (e.g. improvements in technology of solar panels) and

(ii) Banks' direct exposure to sectors with immediate or emerging elevated environmental risks (e.g. mining and coal, unregulated utilities and power companies).

[20] For example, Pillar 2 stress testing and Pillar 3 disclosures.

[21] For example, a risk management process that takes into account loan exposures to sectors with immediate or emerging elevated environmental risks and identifies, measures, evaluates, monitors, reports and controls or mitigates concentrations of risk, including those related to the transition to a low-carbon economy on a timely basis.

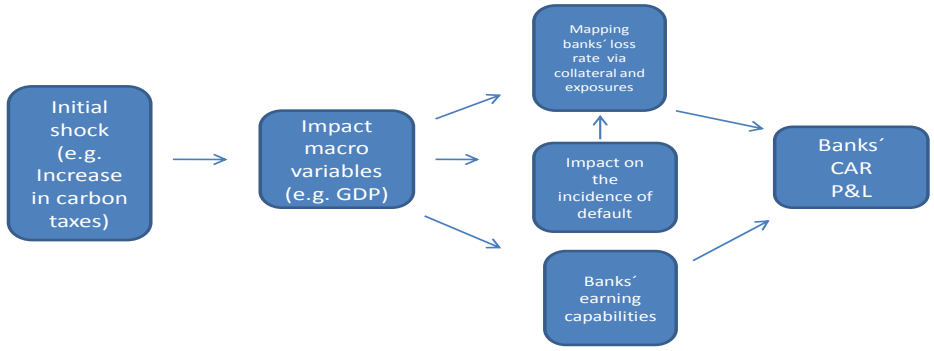
[22] For example, in the US, the Office of the Comptroller of the Currency (OCC) has issued guidelines for supervisors in connection with the supervision of banks' "Oil and Gas Exploration and Production Lending". These are guidelines on prudent credit, interest rate, liquidity, operational and reputational risks management. See https://occ.gov/publications/publications-by-type/comptrollers-handbook/pub-ch-og.pdf.

[23] For example, bank disclosures that reveal inter alia the processes, including environmental risk assessments and business strategies to incorporate the adjustment costs to the transition to a low-carbon economy.

[24] For example, cooperation also encompasses home and host supervisors' assessment of banks' risks exposure to environmental risks as well as systemic risks related to the disorderly transition to a low-carbon economy.

[25] See www.bis.org/publ/bcbs130.pdf . The Core Principles Methodology (2006) is used for assessments of compliance with the BCPs.

Figure 1. Stylised representation of the carbon stress test



Note: The figure presents a view of the way in which a shock might impact banks' capital adequacy ratio (CAR) and profit and loss (P&L).

Source: Author's analysis.

As is the case with typical bank stress testing, in the "carbon stress tests" for each bank and category of credit risk exposure to environmental risk the losses can be computed by combining the stressed probability of defaults (PDs) with the stressed loss giving defaults (LGDs) once the timeframe has been defined (generally one to three years) and the shock has been calibrated. Shocks should also take account of path dependencies (e.g. empirics show that a downgrade is more likely after a previous downgrade). The losses can be measured on an incremental basis (in percentage points) against the losses obtained for the projected baseline scenario and/or against losses obtained from PDs and LGDs observed in a reference year. The presentation of outcomes of the "carbon stress tests" exercises is based on the impact on regulatory capital requirements and the impact on after-tax profits over the defined time frame (provisioning, write-offs and income arrears).

Moody's (2015) highlights three primary credit effects from carbon-reduction policies for non-financial corporates: Regulatory risks; disruptive technology shocks that would have a negative impact on incumbents with limited capability to adapt their business models and direct costs such as the imposition of carbon taxes or purchase of carbon permits.[26] [27]

[26] (i) Regulatory risks (e.g. like the planned closure of all German nuclear generating stations in 2022 or the goal to achieve a certain percentage of power from renewable sources or percentage reduction in emissions); (ii) disruptive technology shocks that would have a negative impact on incumbents with limited capability to adapt their business models (e.g. coal producers face long-term demand for carbon-intensive energy but also suffer from other more immediate factors, such as the impact of the US shale gas boom); and (iii) direct costs such as the imposition of carbon taxes or purchase of carbon permits (e.g. carbon-emitting plants that incur carbon taxes, plants that must buy emissions credits to operate and plants that must install environmental equipment to continue to operate).

[27] Moody´s (2015) defends the co-existence of environmental risks with other drivers of credit risk. Environmental risks are one of the drivers of credit risks. It considers environmental risks vis-à-vis other issuer or sector characteristics that may mitigate or exacerbate their impact. For example, for an industry that contends with environmental risks as well as other risks and future liabilities (e.g. pensions), their significance to ratings does not lie in analysing exactly how much pressure environmental risks represent, but rather in assessing in aggregate how the totality of risks will affect an issuer's default and recovery. At present, direct climate change hazards are, in general, not a material driver for credit ratings.

The sensitivity of loan quality can be assessed for each loan across all loans in the portfolio using special models (see Annex 1 for an example).

From the viewpoint of the transition to a low-carbon economy, longer timeframes give borrowers more time to adapt and increase the likelihood that technology will change or that lower cost solutions can be implemented. It also gives a borrower the opportunity to change its business model or its balance sheet in order to adapt to long-term environmental risks. However, this rationale does not apply in the case of credit event risks with low probability and high severity, which can take place in the transition to a low-carbon economy (e.g. sudden regulatory changes, liabilities from environmental disasters).

Indeed, further analysis is needed to define climate change risks and understand transmission. Credit risks related to the transition to a low-carbon economy merit continued attention as additional information becomes available to inform credit risk assessments. Against this background, the design of consistent and comparable environmental risk exposure data across countries as well as reliable and efficient climate-related financial disclosure rules are paramount. At present, although most G20 jurisdictions have some type of rule or regulatory guidance that requires climate-related disclosure for at least some corporations, a limited number pertain directly to climate-related financial risks. This can be explained partly by the lack of a generally agreed-upon definition of "material" climate risk that triggers disclosure requirements (TCFD, 2016, p. 15) comparable to the Moody's (2015) definition of sectors exposed to elevated environmental risk.

C) Conceptual framework for (new) prudential regulatory requirements: Environmental aspects

If the impact of environmental risks results in credit losses of certain bank exposures (e.g. due to the negative impact on the borrower's credit standing as a result of the obsolescence of the technology used for the production of solar panels), such losses would be covered with loan loss provisions, which would have a negative impact on banks' after-tax profits.

If environmental risks have a permanent impact through the economic business cycle and permanently increase the long-term PD of exposures to elevated environmental risk sectors or sovereigns, prudential regulators should consider a revision of the minimum capital requirements. They should base their revision on the carbon intensity of individual exposures via the increase of the asset risk weights in order to curb banks' incentives to accumulate exposures subject to elevated environmental risks, hence, a penalisation prudential regulation.[28] This subsequent increase of the minimum capital requirement associated with that asset class (including off-balance sheet exposures) should cover any unexpected losses.

Another measure that regulators may consider to discourage environmental risks relates to the potential revisions to banks' large exposures framework. The goal of these measures is to place a quantity-based limit on exposures relative to a bank's Tier 1 capital and/or price-based

[28] Indeed, it could be argued that large uncertainty exists about the particular quantification of the impact of the environmental risks, which makes it difficult to calibrate risk weights.

constraints (or a combination of both) on the amount of exposures to sectors/sovereigns with elevated environmental risk – i.e. risk-weight add-ons. Disincentives could also be based on risk-weight add-ons in incremental steps as large exposures increase as a percentage of Tier 1 capital instead of a flat risk-weight add-on. However, in addition to the difficulties of calibrating the risk weights, the downside of price-based constraints is that they may not be sufficient to promote change in bank behaviour. Furthermore, risk-weight add-ons based on the amount of a bank's exposure may not be sufficient in case of severe shocks due to a disorderly transition to a low-carbon economy.

Last but not least, prudential supervisors could consider transparency requirements via enhancements to the Pillar 3 disclosure requirements in the context of the Basel III framework, which could include semi-annual disclosure requirements related to environmental risk exposures to corporate and sovereigns as well as their risk weights. Enhancements could include a breakdown by accounting classification as well as a breakdown by portfolio duration.

At present, most supervisory agencies in the G20 countries do not believe that minimum capital requirements (or prudential regulatory requirements in general) should be used to limit environmental risks (Alexander, 2014).

4. Conclusions and some policy reflections

The banking sector is most immediately affected by the financial risks associated with the disorderly transition to a low-carbon economy, which could affect banks' exposure to systemic risk both via impaired GDP growth and banks' exposure to elevated environmental risk assets. Banks are slowly growing aware of these considerations.[29]

As of December 2014, the (syndicated) loan exposure to elevated environmental risk sectors in the five main banking sectors was estimated to amount to approximately €1.35 trillion, mostly to companies involved in the exploitation of oil and gas and power generation. Moreover, these sectors show high leverage ratios, a fact that aggravates potential systemically important second-round effects. Those exposures account for a non-negligible percentage of total assets of the banking systems in the respective countries, although comparisons are limited by the differences in the accounting frameworks. In addition, banks are exposed to environmental risks in their equity and bond (corporates and sovereigns particularly LIDCs) portfolios.

Against this background, the objective of prudential policies should be to internalise the potential negative externalities associated with climate change by both banks and their prudential supervisors. Short-term policy action should aim at obtaining a better understanding of the direct exposures to high environmental risk sectors, which demands a reliable and fully

[29] For example, in November 2016, France's Société Generale announced that it will stop financing coal-powered electricity plants starting from January 2017, and increase its support for renewable energy projects and scale back outstanding loans to the coal industry "*with a goal of reducing the proportion of coal-fuelled share in power production financed by the bank to 19 percent by 2020*" (see http://af.reuters.com/article/commoditiesNews/idAFL8N1CX4K5)..

harmonised statistical framework that allows both banks and their supervisors to make a detailed identification of sectors exposed to high environmental risks along the SIC (and NACE in the EEA) classification frameworks.

Among the supervisory tools, this paper highlights the importance of credit registers as a tool that facilitates the assessment of environmental risk drivers in "carbon stress tests" formulated to assess the sensitivity of loan quality to changes in climate risk factors such as regulatory risks, disruptive technology shocks and/or direct costs such as the imposition of carbon taxes/purchase of carbon permits. To the extent that environmental risks could permanently increase the long-term probabilities of default of homogeneous loan portfolios through the business cycle, prudential regulators should consider a revision of banks' minimum capital requirements.

Last but not least, a comprehensive approach to an orderly transition to a low-carbon economy would require prudential supervisors and banks to internalise environmental risks in their governance systems. Revisions of the assessment methodology of the Basel Core Principles for Effective Bank Supervision should be considered to take environmental aspects into consideration.

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Annex 1. Models for climate change factors

Models can be formulated to assess the sensitivity of loan quality, for each loan across loan portfolio categories, to changes in macroeconomic conditions as well as climate factors.

$$\text{NPLi,t} = \alpha_0 + \beta(Climate\ factor)_{i,t} + \alpha_1\ \text{NPLi,t-1} + \sum_{s=0}^{K} \beta\ \text{F,t} - \text{s}\ \ \text{MACRO F,t-s} + \varepsilon_{i,t}$$

Where NPLi,t stands for the logit transformation of non-performing loans (NPLs) as a ratio over total loans of credit institution i in year t, α_0 stands for the fixed-effect for credit institution i, β gauges the specific climate factor i in year t and MACROF, t-s stands for macroeconomic factor F, in period t-s (s is the time lag).

The typical macroeconomic specifications include GDP growth and long-term interest rates but could also include sectoral economic variables. An example of climate factors for a particular sector is the value of stranded assets due to new disruptive technologies over profits before taxes of that particular sector. The regression analysis would show the statistical significance of this environmental factor.

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