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Kevin J. Stiroh

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Climate Change and Double Materiality in a Micro- and Macroprudential Context

Kevin J. Stiroh¹

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Abstract

This paper presents a stylized framework of bank risk-taking to help clarify the concept of “double materiality,” the idea that supervisory authorities should consider both the risks that banks face from climate change and the impact of a bank’s actions on climate change. The paper shows that the concept of double materiality can be coherently embedded in a microprudential framework, but the practical implications could be quite similar to the implications of a single materiality perspective. The importance of a double materiality perspective becomes larger when one considers macroprudential objectives driven by financial sector externalities. The framework illustrates the critical importance of being clear on the supervisory mandate and objectives when assessing policy alternatives.

¹Senior Advisor, Division of Supervision and Regulation, Federal Reserve Board of Governors. The views expressed in this paper are those of the author only and do not necessarily reflect those of the Federal Reserve Board. Thanks to Laurent Clerc, Paul Fischer, Beth Kiser, Asad Kudiya, Jose Lopez, Don Morgan, Michael Palumbo, and John Schindler for helpful discussions and comments on an earlier draft. Any remaining deficiencies are my own.

I. Introduction

The financial risks of climate change are now a topic of considerable focus for central banks and supervisory authorities focused on prudential risks and financial stability issues.² One theme that has emerged from this work is a deeper appreciation of the complexity of the potential impact of climate change across firms, jurisdictions, financial systems, and economies. From a supervisory perspective, this complexity reflects a wide range of factors including the uncertain links between the climate and the economy, financial sector amplifiers and mitigants, the potential for general equilibrium effects as businesses and consumers adjust and adapt, and differences in statutory mandates across supervisory authorities.³

This paper presents a stylized framework of bank risk-taking to help clarify the concept of “double materiality,” the idea that supervisory authorities should consider both the risks that banks face from climate change and the impact of a bank’s financial activities on climate change. By contrast, a “single materiality” perspective includes only the impact of climate change on a bank’s risk. This topic has emerged as an issue in the development of an internally coherent framework for microprudential supervision, macroprudential or financial stability analysis, and disclosure.⁴

In order to assess these two perspectives in a systematic manner, one needs working definitions of single and double materiality. These definitions can then be linked to microprudential objectives related to the safety of individual firms and to macroprudential objectives related to the stability of the financial sector as a whole through financial sector externalities in order to form an internally coherent framework for policy discussions. This paper takes an entirely analytical approach to facilitate an orderly assessment and does not take a normative position on the appropriateness or efficacy of any particular policy.

The paper defines double materiality to include feedback effects to bank risk that come from a bank’s contribution to climate change. Double materiality defined this way can be coherently embedded in a microprudential framework, but the practical implications could be quite similar to the implications of a single materiality perspective. Note that if the core issue is that some assets, say loans to greenhouse gas emitting firms, are thought to be riskier than other assets for a lender, then the introduction of double materiality does not seem necessary. That type of risk differential is a standard part of risk management with heterogeneous assets, although one might require additional risk

² See Financial Stability Oversight Council (2021) and Financial Stability Board (2020, 2022) for a discussion of financial stability issues and Network for Greening the Financial System (2021) for a broad overview of supervisory issues and recent actions.

³ See Basel Committee on Banking Supervision (2021b, 2021c) for a discussion of the conceptual and empirical challenges associated with identifying and measuring the financial risks of climate change.

⁴ European Commission (2019, 2021), European Banking Authority (2021, 2022), and NGFS (2021) discuss views from a supervisory perspective. Value Reporting Foundation (2020) and GRI Global Sustainability Standards Board (2020) present views from the private sector.

indicators to effectively measure a new risk like climate-related transition risk. A meaningful definition of double materiality seems to require additional mechanisms like a direct feedback effect to bank risk.

The importance of a double materiality perspective becomes larger in a broader framework with macroprudential objectives that incorporate financial sector externalities. The macroprudential intuition is straightforward: incorporating the impact of a bank's activities on other banks' risks increases the aggregate impact of the financial services that contribute to climate change. The current framework for globally systemically important banks (GSIBs), however, does not seem like the appropriate approach to deal with the financial risks of climate change. Finally, an even broader set of policy objectives could incorporate additional climate externalities outside of the financial sector, but that is only relevant in jurisdictions with an explicit supervisory mandate to pursue those broader objectives. A key conclusion is that any climate-related policy needs to be developed and critically assessed relative to the specific mandate of the authority considering it.

The paper is organized as follows. Section II provides background information on single and double materiality, supervisory mandates, and climate change relevant for supervisory authorities. Section III presents a stylized model of bank risk-taking that includes the impact of climate change and allows discussion of the single and double materiality perspectives. Section IV draws implications for microprudential and macroprudential policy. Section V concludes and suggests several areas for future research.

II. Background

A. Single and Double Materiality

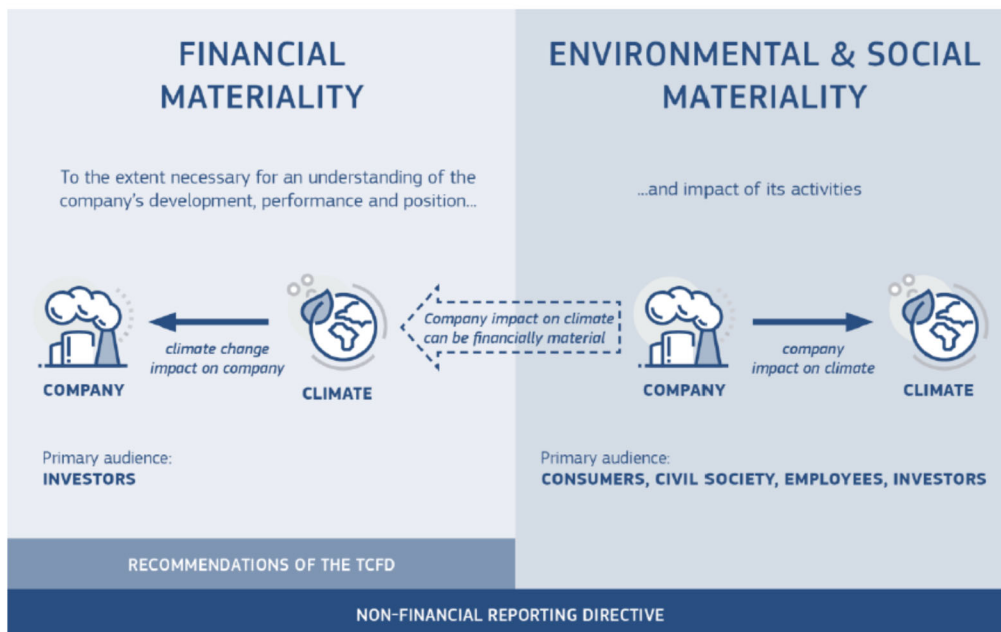
Double materiality has been defined by the European Banking Authority (EBA, 2021, 2022) to include two links between bank activity and climate change – the impact of climate change on a bank and the impact of a bank's activities on the climate. A double materiality approach includes both perspectives, while a single materiality approach includes only the first link from climate change to bank risk. As an example of this double materiality perspective in practice, European Commission (2021, Section III) states that the financial sector needs to be more resilient to climate-related risks and to improve its contribution to sustainability.

More precisely, a “financial materiality” or an “outside-in” perspective captures the impact of climate change on a particular bank. EBA (2021, p32) describes this as the impact of environmental, social and governance (ESG) factors, which includes climate change, on a company's economic and financial activities throughout their entire value chain (both upstream and downstream), affecting the value and returns of such activities. As an example, this could include the credit losses associated with more severe or more frequent extreme weather events. By contrast, an “environmental materiality” or an “inside-out” perspective captures the impact of the bank's activities on climate change. EBA (2021, p32) describes this as the impact of a company's economic and financial activities on ESG factors, which could in turn become financially material when this impact affects the value and returns of the

company’s activities. As an example, this could include the provision of financial services to firms that contribute to climate change through their greenhouse gas (GHG) emissions.⁵ These two types of relationships define the double materiality perspective. By contrast, the single materiality approach includes only the financial materiality or outside-in perspective.

In the context of disclosure, European Commission (2019) states that the Non-Financial Reporting Directive has a double material perspective that includes a company’s “development, performance, position and impact of its activities (p6)” and “impact of [the company’s] activities indicates environmental and social materiality (p7).” Disclosure is relevant if climate is a material issue from either of the following perspectives:

The double materiality perspective of the Non-Financial Reporting Directive in the context of reporting climate-related information



⁴ Financial materiality is used here in the broad sense of affecting the value of the company, not just in the sense of affecting financial measures recognised in the financial statements.

One can also think about these two perspectives through the lens of strategic choices related to strategy and corporate social responsibility at individual banks. The Glasgow Financial Alliance for Net Zero (GFANZ, 2021), for example, reports that over 450 firms from 45 countries have committed \$130 trillion of private capital toward “transforming the economy for net zero.”⁶ This includes science-based

⁵ See Partnership for Carbon Accounting Financials (2020) for a detailed description about how a bank could measure its “financed emissions.”

⁶ A net zero commitment, generally, is a firm’s pledge to transition its own operational and attributable GHG emissions to align with decarbonization pathways that are consistent with global ambitions to have net zero emissions by 2050. GFANZ (2021) provides details.

targets for committed firms to achieve net zero by 2050 with specific interim targets and reporting standards.

Many individual firms have announced commitments to support the economic transition to net zero by 2050, and the Institute for International Finance (IIF) reports that financial firms have a major role to play in decarbonizing the global economy (Gibbs et al. (2021)). It is unclear whether these commitments are made from a narrow perspective focused on an individual bank's own return, risk and valuation, which are more consistent with a single materiality perspective, or from a broader perspective linked to mitigating climate change itself, which are more consistent with a double materiality perspective. Either could be appropriate for a private firm from a strategic perspective, but they may have different implications for investors, stakeholders, and supervisors.

B. Supervisory Mandates

The distinction between single and double materiality is central for discussion of the appropriate form of supervision to address the financial risks of climate change. The Basel Committee on Banking Supervision (BCBS, 2020) concluded that while a large majority of respondents to its survey do not have an explicit mandate with regard to climate-related financial risks, a majority of members considered it appropriate to address climate-related financial risks within their existing regulatory and supervisory framework. This risk management perspective views climate change as a risk driver that potentially could materialize as traditional prudential risks such as credit, market, liquidity, and operational risk (BCBS (2021b)). This approach is consistent with the single materiality perspective that focuses on the impact of climate change on an individual bank.

This mandate question adds complexity to supervisory discussions because central banks and supervisory authorities have different mandates and responsibilities with respect to climate change. In the U.S., for example, Federal Reserve (2021) states that the Federal Reserve works through its existing mandates and authorities to address the implications of climate change, particularly through the regulation and supervision of financial institutions and the stability of the broader financial system. The primary responsibility for addressing climate change itself rests with elected officials. Federal Reserve (2020a, 2020b) provide additional detail on these financial risks from a macroprudential and microprudential perspective. This supervisory approach is consistent with a single materiality perspective.

Other central banks have different mandates. The European Central Bank, for example, has a primary mandate around price stability, but a secondary mandate, to be conducted "without prejudice" to its primary mandate, to "support the general policies in the [European Union (EU)]" (European Union, EU (2007)). The broader EU objectives include environmental-related goals. In the context of the regulatory capital framework, however, EBA (2022) concludes that "prudential regulations should reflect the risk profiles of exposures and should not be used for other policy purposes (p10)."

Similarly, the Bank of England has a primary mandate around price stability, but a secondary objective to support the broader government policies (Bank of England (1998)). More recently, in the

United Kingdom, HM Treasury instructed the Bank of England's Prudential Regulation Committee to "have regard to the government's commitment to achieve a net-zero economy by 2050 under the Climate Change Act 2008 (Order 2019) when considering how to advance its objectives and discharge its functions" (HM Treasury (2021)). In the context bank capital, Bank of England (2021) concludes that the regulatory framework is best positioned to deal with the consequences of climate change, rather than the underlying causes.

To the extent these broader mandates are intended to support a transition to a low carbon economy and promote broader sustainability objectives, they could be more supportive of a double materiality perspective. As discussed below, a critical question is how these multiple mandates are operationalized .

C. Climate Change

Climate change reflects a complex set of relationships between physical events and human actions (Intergovernmental Panel on Climate Change (IPCC, 2022)). Rudebusch (2019) provides a useful summary that describes the economic and financial impacts and linkages. As a simplified, working definition for supervisory purposes, climate change refers to the long-term shifts in temperatures and weather patterns largely attributable to increased levels of atmospheric carbon dioxide produced by the burning of fossil fuels. These impacts can be both chronic (e.g., rising sea levels or higher mean temperatures) and acute (e.g., more frequent and more intense extreme weather events). As a simplification, climate change depends on cumulative GHG emissions, which in turn depend on a host of other factors such as the level and composition of macroeconomic activity, climate policy choices such as carbon taxes or emissions trading systems, technological innovation, and investor and consumer preferences such as ESG investing trends or household demand for electric vehicles.

A standard approach is to consider the impact of climate change in terms of physical risks and transition risks (BCBS (2021b), FSOC (2021)). Physical risks refer to the economic costs and financial losses resulting from acute events like increasing severity and frequency of extreme weather events or chronic events like changes in precipitation, extreme weather variability, ocean acidification, rising sea levels, and rising temperatures. Transition risks refer to the risks related to the process of adjustment towards a low-carbon economy including climate policies, macroeconomic and sectoral outcomes, innovation, and changes to investor or consumer sentiment. Both are relevant for bank risk managers and for supervisors.

In the context of the double materiality discussion and bank supervision, transition risk is the most relevant risk concept because it can reflect bank activities that are most likely to contribute to climate change, which can then feedback and impact the bank's risk profile. The GHG emissions of a bank borrower, for example, are part of a bank's "financed emissions," which are both one measure of a bank's contributions to climate change and one factor that determines the transition risk that a bank faces (BCBS (2021c, p20 and p23) and Partnership for Carbon Accounting Financials (2020, p20 and

p25)). By contrast, a bank's exposure to physical risk is unlikely to be a determinant of the impact of a bank's activities on the climate itself.

III. Stylized Framework for Bank Risk-Taking

This section presents a stylized framework of bank risk-taking that incorporates the potential impact of climate change. This can be used to assess single and double materiality perspectives in the context of microprudential or macroprudential policy objectives. This approach is written in terms of banks and lending, but could also apply to a range of financial intermediaries providing other financial services and facing the same types of risk management issues.

This stylized framework is based on a simple, partial equilibrium model where a bank chooses the level of lending where the marginal cost of lending (such as higher risk) equals the marginal benefit (captured by the yield). This implies that a higher marginal cost of lending leads a bank to lend less, all else equal. In this representation, capital is fixed and lending is the only variable that a bank chooses. A richer model could include a number of features: the costs and benefits of capital in a world of uncertainty so the level of capital would be determined endogenously; a dynamic approach that includes risk-based pricing with a more explicit model of the costs and benefits of lending over time; a broader description of customer relationships with other additional financial services; and uncertainty about the size and stability of these relationships. Despite these simplifications, the framework is a useful tool to facilitate a structured discussion about how alternative perspectives on materiality tie to different supervisory objectives.

A. Bank Risk and Climate Change

A bank's risk depends on a wide range of external and internal factors, including the composition of its lending or other asset holdings and can be measured in many ways, e.g., an empirical estimate of the probability of default, market variables such as price-to-book ratios or price volatility, or supervisory assessment and external ratings. As mentioned above, bank supervisors and risk managers would typically think about risk relative to some ability to absorb losses such as bank capital. Here, the focus is on marginal changes to risk, implicitly assuming capital and other risk mitigants are held fixed.

In this conceptual set-up, a bank chooses its lending to GHG-emitting firms (E_i) and non-GHG-emitting firms (N_i). The costs of this lending include traditional banking risks associated with lending and captured by familiar metrics such as probabilities of default (PD), loss given default (LGD), and exposure at default (EAD), plus any climate-related risks that can differ by borrower type. Bank risk also depends positively on climate change (C) directly to the extent that climate change impacts the level of physical or transition risk for a given portfolio of exposures or a bank's operational risk. Finally, bank risk depends on other traditional risk factors (*Other*) such as its leverage, risk characteristics of other assets, and macroeconomic factors such as the business cycle or interest rate environment. Bank risk, R , is represented as:

$$R_i = f_i(E_i, N_i, C, Other)$$

In this framing, banks choose their exposure to transition risks through their lending to GHG-emitting firms, which are potentially most impacted by climate-related policies, technological change, or shifts in investor and consumer sentiment and thus face transition risk. One can think of the broader impact of climate change as a factor that shifts the risk function, e.g., as the climate changes, physical and transition risk increases for a given level of lending, portfolio composition, and risk characteristics. This is consistent with BCBS (2021b, 2021c), which describe climate change as a cross-cutting risk driver that affects prudential risks such as credit, market, or operational risk. Finally, note that this model doesn't explicitly model the marginal benefits of lending to either type of firm, which are captured in the yield and incorporated into the firm's optimization decision.

As described in Section II, climate change depends on many factors such as cumulative GHG emissions, the level and composition of macroeconomic activity, climate policy choices such as carbon taxes or emissions trading systems, technological innovation, investor and consumer preferences, and non-bank financing of emissions. To tie back to the bank-level determinants of risk, this set-up breaks out total bank lending to GHG-emitting firms (E), where total lending to emitters is summed across banks, $E = \sum_i E_i$. X includes all other factors that determine climate change that are independent of bank lending. Climate change, C , is represented as:

$$C = g(E, X)$$

For simplicity, this paper does not model all other factors that determine climate change in X , but rather focuses on the marginal impact of a bank's lending on climate change, which is necessary for a double materiality perspective. The implicit assumption is that a bank's lending to a GHG-emitter is a good proxy for the contribution to climate change through financed GHG emissions.

B. Alternative Materiality Perspectives

This section provides working definitions of single materiality and double materiality within a microprudential context. This approach is necessarily precise, and perhaps rigid, from a definitional perspective in order to provide structure to the discussion. It is possible, of course, to debate these definitions and develop alternative ones. For example, the Network for Greening the Financial System (NGFS, 2021) concludes that there is no clear distinction between single and double materiality, particularly in the long-run if an entity's impact on the environment and society have a further impact on an entity's enterprise value. European Commission (2019) concludes that these perspectives already overlap and may increasingly overlap as a firm's climate impacts become financially material.

In this framework, "single materiality" is defined to capture the impact of climate change on an individual bank's risk. Using the EBA framing, this includes only financial materiality or the outside-in link. In this approach, the impact of climate change is viewed by a bank as if it is *exogenous*, so a bank manages its climate-related risk through the amount of lending to GHG-emitting firms. One can represent this as the marginal impact of a bank's lending to a GHG-emitting firm on its risk:

$$\left(\frac{\partial R_i}{\partial E_i}\right)_{Single, Microprudential} = f_{i,E_i}$$

where f_{i,E_i} is the contribution to bank i 's risk from an incremental dollar of lending to GHG-emitting firms by bank i .

A bank's lending decisions impact the bank's risk only through the direct impact on its portfolio as in a traditional risk assessment. In this case, f_{i,E_i} measures the marginal risk of lending to GHG-emitters and reflects all risk characteristics of those activities, including the factors that determine relative riskiness of lending to GHG-emitters such as traditional prudential risks, new transition risk, or increased reputational risk.

From this single materiality perspective, climate change itself is viewed as if it is exogenous by an individual bank and it impacts the riskiness at all levels of lending by shifting the risk function out. Note that this does not imply that climate change must impact all borrowers or exposures equally; rather, climate change increases risk across the portfolio, effectively shifting the risk function.

In this framework, "double materiality" incorporates the impact of a bank's actions on climate change when it creates additional risk to the bank. Using the EBA framing, this includes both financial materiality and environmental materiality where climate change is viewed as *endogenous* from the bank's perspective. For example, EBA (2021, p32) states: "both of these perspectives should be taken into account when evaluating ESG risks, but the latter only to the extent that its related impacts further aggravate the impacts from the outside-in perspective, as in that case they would have a negative impact on the counterparty or invested assets."

Staying within a microprudential approach, one can define double materiality as a broader measure of the marginal impact of a bank's lending decision on risk as:

$$\left(\frac{\partial R_i}{\partial E_i}\right)_{Double, Microprudential} = f_{i,E_i} + f_{i,C} * g_{E_i}$$

where the marginal impact of climate change on a bank i 's risk, $f_{i,C}$, and the marginal contribution to climate change of the bank's lending to GHG-emitters, g_{E_i} are both positive. As a result, the marginal risk of lending to a GHG-emitting firm is larger in the double materiality case than in the single materiality case:

$$\left(\frac{\partial R_i}{\partial E_i}\right)_{Single, Microprudential} < \left(\frac{\partial R_i}{\partial E_i}\right)_{Double, Microprudential}$$

$$f_{i,E_i} < f_{i,E_i} + f_{i,C} * g_{E_i}$$

The difference in microprudential impacts reflects the feedback effects through the climate, i.e., lending to GHG-emitters damages the climate (g_{E_i}), which further increases a bank's own risks ($f_{i,C}$).⁷ The climate change-driven shift of the risk function can lead to higher bank risk from both GHG-emitters and non-emitters, which the bank now incorporates. Of course, other factors also impact climate change, including the broad set of factors described above and other banks' lending to GHG-emitters, but those are outside the control of the bank.

It is important to emphasize that both of these perspectives are entirely microprudential in nature because they only include the impact on the bank's own risks. As a result, an optimizing bank would incorporate these channels in their own choices, so the practical issue that distinguishes them is the size of the additional impact channel in the double materiality perspective.⁸ This is discussed in the following section.

Conceptually, the critical distinction within the microprudential approach is that a bank with a single materiality perspective views climate change as exogenous, $g_{E_i} = 0$, while a bank with a double materiality perspective views climate change as endogenous, $g_{E_i} > 0$. This may suggest a somewhat passive approach to risk management within the single materiality perspective as there is no incentive to prevent the build-up of risk in a proactive manner by reducing climate change itself. By contrast, double materiality incorporates a more proactive, pre-emptive approach to risk management as banks' incorporate the risk implications of their lending decisions that feedback through climate change itself. Gourdel et al. (2022), for example, conclude that incorporating the feedback effects from firms' investment decision for the transition scenarios can have a material impact on economic outcomes. Note, however, that this analysis includes the impact of an aggregate financial sector, rather than an individual firm, which may be more relevant from a macroprudential perspective.

As a final point, note that there is no assumption that the marginal risk of lending to GHG-emitters and non-GHG-emitters is the same or that any differential was constant over time. For example, all else equal, one might believe that lending to GHG-emitters comes with higher prudential risks, transition risks, or increased reputational risk for the bank so that:

$$\left(\frac{\partial R_i}{\partial E_i}\right) > \left(\frac{\partial R_i}{\partial N_i}\right)$$

This type of risk differential should be captured within a bank's traditional risk management framework that determines a bank's lending activities. This is risk management with heterogeneous

⁷Alternatively, a bank could provide financing to a firm with activities that slow climate change, e.g., financing of renewable energy alternatives or carbon capture technology. That type of lending could be viewed as a positive externality where the externality takes the opposite sign.

⁸ While the double materiality perspective is broader than the single materiality perspective, it is still inherently a partial equilibrium exercise. A full general equilibrium exercise could also model changes in the demand for financial services from both GHG-emitting and non-GHG-emitting firms.

assets and, conceptually, there is no need to introduce the concept of double materiality to account for this type of risk differential. In that sense, double materiality is not a relevant concept if the only issue is heterogeneous risks across assets. Rather, one needs some type of additional mechanism such as the feedback effect described above to have a meaningful definition of double materiality.

Practically, one would need to identify the appropriate risk indicators (e.g., location of borrower collateral to measure physical risk or exposure to carbon-intensive sectors or vulnerability to shifts in investor preference to measure transition risks) and develop evidence of a risk differential. Both are challenging due to data limitations, the inherently forward-looking nature of climate-related risks so that historical data may be less useful as a predictor of risk, and identification challenges in the estimation process. NGFS (2020, 2022) discuss some of these challenges and concludes that financial institutions have not found strong evidence of a risk differential between so-called “green” and “brown” assets, which they attribute to methodological and data-related challenges, particularly the backward-looking nature of many studies and the presence of confounding factors.

This is an important question for further work, which could identify which metrics and risk indicators might be appropriate to measure relative risks and how that differential might be evolving. Forward-looking scenario analysis such that performed by European Central Bank (ECB, 2021) and Autorite de Controle Prudentiel et de Resolution / Banque de France (ACPR, 2020) seems like a valuable approach to identifying these potential differentials.

IV. Implications

This section draws several conclusions that are relevant for discussions about the materiality perspectives and policy objectives. This section begins with a microprudential approach that reflects only the risks to a particular institution and then incorporates a broader set of objectives including macroprudential links through financial sector externalities, the framework for systemically important banks, and broader climate-related externalities to show how the approach to climate change depends critically on the underlying supervisory mandate and objective.

These objectives overlap in some cases as many supervisory authorities consider climate change through both microprudential and macroprudential mandates. Following the financial crisis in 2008, for example, BCBS revised its core principles to emphasize “the importance of applying a system-wide, macro perspective to the microprudential supervision of banks to assist in identifying, analysing and taking pre-emptive action to address systemic risk (BCBS, 2019).” Bank of England (2021), European Commission (2021), and Federal Reserve (2021) all have both microprudential objectives related to the safety and soundness of individual firms and macroprudential objectives linked to financial stability. Nonetheless, it is useful to clearly define the microprudential and macroprudential impacts when developing a coherent policy framework and assessing alternative options.

A. Microprudential Objectives

In general, bank risk managers and supervisors make an assessment about an acceptable level of risk to the firm and apply various mitigants, controls, and constraints to achieve it. This type of microprudential approach is focused on the risk of individual institutions. As a specific example, a value-at-risk (VAR) framework might set the appropriate amount of bank capital to cover unexpected losses with a certain level of confidence for a credit portfolio (BCBS (2005)). A bank with a higher risk portfolio is expected to maintain higher levels of capital relative to risk-weighted assets or to appropriately reserve against expected losses in its loan portfolio. While bank risk managers and microprudential supervisors might have different views on what that acceptable level of risk is, both only focus on the risks to an individual institution, e.g., the link between a bank's own actions and its own solvency or distress.

Both the single and double materiality perspective defined above by $\left(\frac{\partial R_i}{\partial E_i}\right)_{Single, Microprudential}$ and $\left(\frac{\partial R_i}{\partial E_i}\right)_{Double, Microprudential}$ are entirely microprudential in nature. That is because both measures of marginal risk reflect the impact of a bank's lending decision on its own risk. There is no introduction of externalities to other parts of the financial sector or to broader society impacts that move beyond a focus on a single bank's risks or solvency. The potential impact on other parts of the financial sector or economy are addressed below.

The marginal impact of a bank's lending decision, and thus the optimal level of lending, does depend on the specific materiality perspective of the bank. With a single materiality perspective, the only relevant risk at the margin for the bank is the direct impact due to changes in lending exposures to GHG-emitting firms. With a double materiality perspective, the bank's view of the marginal impact on risk also incorporates feedback effects through climate change itself back to the lending firm, which can impact the overall risk of its entire portfolio. As a result, double materiality implies higher marginal cost of lending relative to a single material approach due to the feedback effects, so optimal lending to GHG-emitters would be lower. The key difference is that in the single materiality approach, a bank treats climate change as if it is exogenous and in the double materiality approach the bank treats the climate as if it is endogenous.

One hypothesis, however, is that the marginal impact of any individual bank's lending to a GHG-emitter on climate change, g_{E_i} , is small in a practical sense. This reflects the relatively small size of any individual bank in the global banking system, the relatively small contribution of any particular firm to cumulative GHG emissions, the relative importance of bank lending as a source of financing, and the potential for substitution to other forms of financing for GHG-emitters. On the other hand, one might also consider the persistent impact of climate change on a bank's risk from long-run and irreversible changes, which would increase the potential impact in a discounted value sense. If the net impact is small on net, there may be little practical difference between single and double materiality perspective within a microprudential framework. As a result, an optimizing firm would make roughly the same lending decision from both perspectives.

While any given firm’s impact is small through lending to GHG-emitters, the aggregate effect could be large (Gourdel et al. (2022)). If many banks choose to restrict lending to GHG-emitters, cumulative GHG emissions could decline so climate change itself would be less severe to the benefit of all. No individual bank, however, has a strong incentive to restrict lending so the public good of a stable climate may be under-provided. The magnitudes of this impact would depend on a number of general equilibrium factors such as the ability of GHG-emitters to find alternative financing, the nature of their financing arrangements, and the relative elasticity of different GHG-related activities. This is an important area for future empirical work. Finally, this type of market failure seems relevant for policymakers with a macroprudential or macroeconomic objective and seems consistent with the “tragedy of the horizons” in introduced by Carney (2015), but is outside of this definition of a purely microprudential objective.

B. Broader Objectives

A broader perspective could include several channels that make the double materiality perspective larger quantitatively. These could include various types of financial sector externalities or broader climate-related objectives that extend beyond the financial sector. As stated above, the Bank of England, the ECB, and the Federal Reserve all have macroprudential objectives, and the Bank of England and ECB also have mandates to support broader government sustainability objectives. In this framing, a macroprudential objective differs from a microprudential one because it incorporates financial sector externalities – the impact of one firm’s actions on other financial firms.

i. Financial sector externalities

Financial sector externalities can be defined as the impact of one banks’ lending on the risk of other banks through the climate feedback channel. Following the approach above, one can define a climate-related financial sector externality as the marginal contribution to bank j ’s risk from an increase in lending to a GHG-emitter by bank i as:

$$\frac{\partial R_j}{\partial E_i} = f_{j,C} * g_{E_i}$$

This shows the link from one bank’s lending to a GHG-emitter through the impact on climate change and back to the risk of a different bank. That is, if one bank finances GHG emissions that contribute to climate change (g_{E_i}), then the climate deteriorates, and a different bank will face higher physical and transition risk as a result ($f_{j,C}$). This external effect is relevant for all other banks, and the cumulative financial sector externality is:

$$\text{Financial Externality} = \sum_{j \neq i} \frac{\partial R_j}{\partial E_i} = \sum_{j \neq i} f_{j,C} * g_{E_i}$$

The implication of incorporating these externalities is to raise the marginal social cost of bank lending relative to the pure microprudential case, which further reduces the optimal amount of lending

to GHG-emitters from a macroprudential perspective. The marginal cost of lending to GHG-emitters in each case is:

$$\left(\frac{\partial R_i}{\partial E_i}\right)_{Double, Microprudential} < \left(\frac{\partial R_i}{\partial E_i}\right)_{Double, Macroprudential}$$

$$f_{i,E_i} + f_{i,C} * g_{E_i} < f_{i,E_i} + f_{i,C} * g_{E_i} + \sum_{j \neq i} f_{j,C} * g_{E_i}$$

This wedge between the impact of a bank's lending decision on its own risk and the impact on the risk of other banks is a classic externality. This is one precise way to differentiate microprudential and macroprudential approaches. As with any negative externality, an optimizing firm won't internalize these effects so lending to GHG-emitters is higher than socially optimal when one accounts for financial sector externalities. Similarly, a pure microprudential supervisor won't recognize this externality because it doesn't affect the safety and soundness of the initial bank. These broader costs provide a rationale for a more restrictive approach to regulation for a macroprudential authority relative to a purely microprudential approach. Note that in a single materiality framework where climate is viewed as exogenous, there are no climate-related externalities ($g_{E_i} = 0$) by definition, so one needs a double materiality perspective for this type of macroprudential approach.

Similar to the discussion above, the key questions are about the scale of the link from lending to GHG-emitters to climate change and the impact on other banks in the financial system. To scale the materiality of this macroprudential impact relative to the direct, microprudential impact, one needs to size the external impact – how much does one bank's lending impact climate change in a way that could increase the risk for other banks? This depends on the complexities described above, e.g., the climate sensitivity to GHG emissions, the impact of one firm's finance emissions, and the substitutability of financing for GHG-emitters. Gourdel et al. (2022) use a large macro model to scale these feedback effect and conclude that finance-economy-climate effects are large and can impact appropriate macroprudential policy choices.

This definition of financial sector externality only captures risk to other banks and does not include any broader impacts of climate change outside the financial sector that might be relevant for some policymakers. This is discussed in more detail below.

ii. GSIB framework

The international regulatory community and the U.S. capital framework acknowledge the specific importance of globally systemically important banks (GSIBs) may play (BCBS (2013, 2021a), Federal Reserve Board, (2015a, 2015b)).

The basic intuition is that these “systemically important” firms have distinctive characteristics related to size, interconnectedness, and other factors such that their distress or failure would generate costs for other parts of the financial system and society. In this context, systemic importance is defined by an externality related to the distress or failure of specific firms. The international GSIB framework

addresses this externality by offsetting this systemic impact with the requirement of a lower default probability through higher capital requirements. GSIBs face higher capital requirements, the so-called “GSIB surcharge,” to lower risk and reduce the probability of default (PD) in order to offset higher systemic externalities of failure (loss given default, LGD).

In the context of climate change, a higher capital surcharge in the GSIB framework and an even lower probability of default would require evidence that certain climate-related activities lead to higher losses for society via larger externalities associated with distress or failure. If lending to GHG-emitters increased the banks’ own risks and probability of default directly, those risks would be captured through the microprudential channels described above. If lending to GHG-emitters increases other bank’s risks, those risks would be captured in the macroprudential channel described above.

A conceptual rationale for a higher GSIB surcharge related to climate change requires an argument about larger LGDs for society associated with the failure of GSIB due to climate-related factors. For example, one could argue that the financial sector could be more impacted by the failure of a large bank if it were simultaneously experiencing structural shifts in the economy related to a climate transition. More work on the link between a bank’s LGD and climate change is needed to better understand this potential channel and to support changes to the GSIB framework.

iii. Climate externalities

Governments and policymakers, of course, may want to reduce climate change for reasons other than the impact on risk in the financial sector, i.e., beyond what is in either the microprudential or macroprudential channels defined above. This could reflect the broader costs to society described by IPCC (2022) and would be analogous to the “damage function” approach in integrated assessment models (IAMs) as described by Nordhaus (2017). These functions are a reduced-form approach for capturing the impact of climate through channels such as changes in productivity, mortality, or loss of physical assets. These reflect the fundamental climate-related externalities that drive discussions of broader carbon policies (Metcalfe (2020)) and the work on the social cost of carbon (Rennert et al. (2021)).

In the stylized model above, this would take a broader view of the impact of climate change than the financial sector impact captured by f_C and would include the impact on all parts of society. Incorporating these broader social impacts would further raise the cost of lending to GHG-emitters and suggest a further reduction of lending to slow climate change, i.e., internalize the fundamental climate externality across society rather than just within the financial sector. This is relevant for supervisory authorities only to the extent there is an explicit climate policy mandate and, as discussed above, there is considerable heterogeneity across jurisdictions, e.g., the mandate for the Bank of England and European Central Bank could be interpreted broadly, while the U.S. has a much narrower mandate that does not include supporting broader climate policies outside of financial risks. EBA (2022), however, concludes that the most effective tools for dealing with the fundamental climate externality are those of the political authorities and Bank of England (2021) concludes that the regulatory capital is an

appropriate tool to deal with the consequences of climate change, but not the fundamental causes. An interesting question for further work is to consider how these different mandates could interact and what trade-offs they may create if a supervisory authority took action to pursue the secondary mandate.

V. Conclusions

This paper provides a stylized framework for bank risk-taking to help organize thinking about the concepts of single and double materiality in the context microprudential and macroprudential policy objectives. This can promote an orderly discussion of complex issues to help policymakers link assumptions, mandates, and policy actions. The paper does not take a normative stand on the appropriate policy.

The approach shows that both single and double materiality are internally coherent concepts in a microprudential context, but that the practical difference might be small and depends on a given institution's impact on the climate itself and the size of the feedback effects. A broader macroprudential perspective approach that incorporates financial sector externalities to other financial firms is also internally coherent and consistent with the financial stability mandates of certain central banks and supervisory authorities. Consistent with a standard theory of negative externalities, a macroprudential approach that accounts for a broader set of financial sector effects would lead to greater constraints on the externality-generating activities. An approach focused on GSIBs, however, seems less relevant given the current evidence on the link between climate change and the externalities associated with failure or distress of systemically important firms.

One concern is that this interpretation of single materiality perspective may suffer from a form of "benign neglect," effectively ignoring the important externalities, free-rider problems, or other market failures that are central to the economics of climate change. That perspective, however, necessarily reflects some judgment, and it may be more helpful to ground the discussion in precise definitions that link to statutory mandates and responsibilities. In this context, for example, a macroprudential policy is more restrictive than a microprudential one precisely because it incorporates financial sector externalities, but that doesn't imply that one is more effective than the other. Rather, policy should be assessed relative to the specific mandates and objectives of the relevant authority.

A second insight is that from a microprudential risk management perspective the key policy issue may not be about distinguishing single materiality from double materiality, but rather understanding the bank's marginal risk from exposure to climate-related activities, e.g., lending to GHG-emitting firms relative to non-GHG-emitters. As shown above, nothing in this framework assumes that the marginal risk is the same across different types of firms or constant over time, so the question is ultimately empirical – are there material risk differences between types of borrowers that correspond to climate-related indicators that will inform bank lending decisions? If so, they should be incorporated into traditional risk management approaches for heterogeneous assets and does not require introduction of the double materiality concept.

This is a difficult question, however, due to incomplete data, the potential for future climate-related risks to be different from historical observations, and challenging identification issues. Forward-looking scenario analysis that assesses relative impacts across different bank exposures seems likely to help banks and supervisors better understand the range of potential differences. Understanding different risk impacts is a fundamental component of an effective risk management regime from both a bank and a supervisory stand-point.

This approach suggests a number of specific areas for future research. Conceptual work could embed this type of framing in a more sophisticated model of bank optimization or add detail on the transmission mechanisms from climate change back to bank risk or the interaction between lending to GHG-emitters and non-GHG-emitters. Empirical work could focus on estimating the potential size of the direct and indirect effects, which would inform discussions and comparison of the various policy approaches and what the practical differences between single and double materiality or between microprudential and macroprudential policies might be. Finally, analytical work could further assess how firm's corporate social responsibility objectives and commitments to net zero transition plans should be viewed within a single and double materiality perspective to better understand the impact of the growing use of voluntary net zero commitments.

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