

ECONOMIC POLICY AND ITS IMPACT

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POLICY DEBATE OF THE HOUR

Climate Change: Greening the Economy by Green Finance?

Christa Hainz, Claudio Borio, Stijn Claessens and Nikola Tarashev, Jan Krahnert, Jörg Rocholl and Marcel Thum, Jacob Baylon Schumacher, Rainer Haselmann, Sebastian Steuer and Tobias H. Tröger, Florian Berg, Jason Jay, Julian Köbel and Roberto Rigobon, Emanuela Benincasa, Gazi Kabas and Steven Ongena, Hans Degryse, Tarik Roukny and Joris Tielens



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econPOL FORUM

The financial sector may play a central role in climate change. This is because, ideally, climate policy measures create important incentives for investors throughout the globalized world to redirect their capital in favor of a cleaner production and thus lower emissions. That is why climate policy must consider the link between the real sector and the financial sector.

This transition will not happen by itself. It requires targeted financing measures. To make it effective, policymakers need information about what economic activity, and thus what investment, can be considered green or sustainable. The task is to identify and compile relevant data and provide it to investors in a suitable classification, e.g., via an ESG rating or a taxonomy.

Our authors in the “Policy Debate of the Hour” discuss to which extent green finance can make the economy greener. They also examine the role the financial sector can play in this transition. Among other things, they shed light on how “green” can be measured and look at the role of climate policy and incentive effects. They also provide recommendations for both economic and climate policy.



In our “Economic Policy and its Impact” section, the authors shed light on the question of how teaching evolutionary theory changes students' knowledge and important choices in their life. In “Institutions Across the World” we discuss how policymakers can create incentives for households to follow tax rules when they use household-related services. The section “Big Data-Based Economic Insights” uses a textual analysis to look at remarks made in ECB press conferences.

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Introduction to the Issue on

Climate Change: Greening the Economy by Green Finance?

Christa Hainz

Climate change is currently posing perhaps the greatest challenge to the world and is thus shifting the priorities in economic policy. In order to achieve the goal of transforming economies in an ecologically sustainable way, a massive shift of resources from climate-damaging and emission-intensive economic activity to low-emission economic activity is necessary. This transition of economic activity requires investments on a large scale. The role of the financial sector in this transition is therefore being discussed. Does it only finance the new, green investments or does its role go beyond that? The financial sector must always be considered in conjunction with the real sector and climate policy. Climate policy measures will provide important incentives in a globalized world. Investors will also have to adapt their investment strategy, and the question is what incentives they will need given the investment decision they have taken in the past. Since this transition will not always be smooth, special financing measures will be necessary. A central role in the entire process is played by information about which economic activity and thus which investment can be considered green or sustainable. This information must first be collected. Then it must be made available to investors in a suitable classification, e.g., via an ESG rating or a taxonomy. With this issue, we want to make a contribution to this broad discussion.

Claudio Borio, Stijn Claessens, and Nikola Tarashev argue that the financial sector has a key role to play in supporting the green transition. However, it seems unrealistic to expect financial markets to induce the green transition unless the right signals come from the real economy. They also see the danger of unrealistic expectations setting the financial sector up for failure and derailing the green transition. Both exposure to overvalued emission-intensive assets, but also to overvalued “green” assets or assets that purport to be green, create risks to financial stability.

Jan Krahnert, Jörg Rocholl, and Marcel Thum point out that it is difficult to establish clear links between the origin and the use of funds, which calls into question the usefulness of ESG-oriented financing. They argue that active investors may exert a formative influence on a firm’s environmental and social actions, not least by accepting a personal reduction in earnings. Passive investors will only have an influence if there is a large number of green investors and if markets are characterized by frictions and inefficiencies. In contrast, in the case of the state, investors do not

have this comparable opportunity, as budget planning remains the main responsibility of the legislative power. Regarding the role of the state more generally, they see the problem that the interaction with public policies may render private efforts into green finance ineffective for achieving ESG goals.

Jacob Baylon Schumacher helps clarify the terminology and the relationship between transition and green finance. While both target improvements to environmental outcomes of organizations, transition finance recognizes the importance of accounting for social issues as well as the need to rapidly transition towards more sustainable practices generally. He concludes that as societies begin to seriously speed green transition plans, the role of transition finance will continue to grow.

Information plays a crucial role in the financing process. ESG ratings and taxonomies are two tools for gathering and classifying this information. *Rainer Haselmann, Sebastian Steuer, and Tobias H. Tröger* describe the role of the EU-Taxonomy as an instrument for transparency and disclosure purposes, which provides a binary signal at the level of economic activities. This binary information can then be aggregated on the level of the firm and on the level of investment portfolios. However, professional investors and regulators may instead rely on more advanced and context-specific metrics. Therefore, the controversial classification of gas and nuclear power in the EU-Taxonomy will not have a major impact. They also conclude that green finance policies are no substitute for restrictive environmental regulations such as cap-and-trade schemes or outright prohibitions of certain activities

Florian Berg, Jason Jay, Julian Kölbl, and Roberto Rigobon take up the fundamental discussion of whether ESG ratings can be of any help given that they provide noisy signals about the ESG performance of firms. They argue that if something is important to society, it should be measured, but it also should be understood and recognized that the measurement is imperfect. Based on their findings that there is a positive, economically and statistically significant relationship between ESG scores and stock returns, they argue that the information that ESG raters produce is valuable; that is there is “signal in the noise.” Still, assessing ESG performance is conceptually challenging because contextuality, additionality, and preferences need to be measured. They recommend that regula-

tors should enforce transparency of measurement and aggregation practices to increase competition between ESG raters to incentivize improvement.

Two papers take a look at bank lending, albeit from different angles. *Emanuela Benincasa, Gazi Kabas, and Steven Ongena* start from the fact that there are substantial differences across countries regarding climate policy stringency. They find that banks react to a stricter climate policy in their home country by increasing their cross-border lending to countries with laxer climate policies. The evidence is consistent with the adverse effect of transitional climate risks on firms, possibly reducing banks' domestic loan portfolio performance. The authors call for a global coordination in climate policies, which is needed to prevent race-to-the-bottom behavior.

Hans Degryse, Tarik Roukny, and Joris Tielens look at the effect which new technologies have on banks, or external financiers more generally, that have loans

to traditional, brown firms in their legacy credit portfolio. The authors are interested in the incentive effect this has for the investors to grant loans to greener firms. The challenge is that new environmental technologies threaten the dirty legacy portfolios of external financiers. The authors find in the research underlying this article that investors have an incentive not to finance disruptive green firms in an attempt to protect exposed legacy positions. This incentive renders green disruptors up to 4.4 percentage points less likely to receive external finance. The positive message is that the presence of financiers with a low legacy credit portfolio triggers systemwide incentives to fund green firms. They recommend limited policy interventions to alleviate financial barriers to the green transition.

We hope you enjoy this Policy Debate of the Hour!

Claudio Borio, Stijn Claessens and Nikola Tarashev

Finance and Climate Change Risk: Managing Expectations*

Addressing climate change is one of the most pressing priorities of our time. There is now a broad consensus that climate change is happening, that it could be immensely costly, and that human activity is responsible. The economic growth imperative has overridden sustainability considerations for far too long. From being propounded by a few, fighting climate change has now become a cause of the vast majority.

But it is one thing to recognize the need for policy adjustments and quite another to implement them (Weder di Mauro 2021). “Greening the economy,” i.e., cutting CO₂ emissions to address the “physical risk” of huge climate-induced damage, will call for a major reallocation of resources – a shift from emission-intensive (“brown”) to emission-light (“green”) activities. This reallocation is bound to be painful, hard to engineer and fraught with “transition risks.” It requires major government intervention (e.g., Pisu et al. 2022).

What is the role of the financial sector in this necessarily collective effort? It is sometimes argued that action in the financial sector can compensate for inaction in the real economy. In other words, there are expectations that the financial sector would lead the way, rising above a merely supporting role.

Our view is that these expectations are exaggerated. Finance faces the very obstacles that have hamstrung progress in the real economy. Moreover, seeking to tackle these obstacles first or solely through the financial sector runs the risk of decoupling the sector from the real economy, thereby raising financial stability risks. On top of the well-known risks of omission, i.e., those of failing to anticipate the disruptions that greening the economy would bring, there are also risks of commission.

THE NATURE OF THE PROBLEM

Why has it proved so difficult to tackle climate change?

* The views expressed are those of the authors and not necessarily those of the Bank for International Settlements. This article was first published as a VoxEU column.



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KEY MESSAGES

- **The financial sector has a key role to play in supporting the green transition**
- **It is unrealistic to expect financial markets to induce the green transition unless the right signals come from the real economy**
- **Unrealistic expectations can set the financial sector up for failure and derail the green transition**
- **Risks to financial stability stem from exposure to overvalued emission-intensive assets, but also to overvalued “green” assets or assets that purport to be green**

For a start, there has been a problem of information. For a long time, a major stumbling block was the failure to agree that a problem existed in the first place. Initially, there were doubts about whether increases in global temperatures were significant enough to indicate a trend. Once this was no longer in dispute, fierce disagreements raged over whether human activity was primarily responsible. But now, in response to accumulated evidence and a swell of public opinion spearheaded by the younger generations, policymakers have come to realize that urgent action is needed. Hence the recent pledge by many countries to achieve net zero CO₂ emissions by 2050 (UNEP 2021).

The remaining, and much higher, stumbling block has to do with incentives. For one, while the benefits of a transition will accrue mainly to the yet-to-be-born or the very young and as yet voiceless, the costs will fall mostly on those who can act now. This intergenerational conflict will wane over time but is still very much with us. In addition, even if everyone agrees in principle on the need to act, it is tempting to freeride on the action of others, while avoiding the costs of the transition. Moreover, these costs will be very un-

evenly spread. Within countries, the poorer segments of the population are likely to be the hardest hit, e.g., by higher prices for more polluting energy. Above all, some countries will lose more than others, depending on the exposure to transition risk stemming from the economic structure (e.g., importers or exporters of emission-intensive energy inputs) as well as exposure to physical risk.

Public authorities have not succeeded in overcoming these incentive problems. Distributional issues across and within generations have inhibited the necessary action on the real side of the economy, which is where physical risks originate and where reallocation must take place. In principle, a well-calibrated set of taxes and subsidies – e.g., a carbon tax – can engineer the change, as can quantity and other regulatory limits. But both the measures taken so far and those pledged fall well short of what is needed (IEA 2021).

Can the financial sector substitute for action on the real side and possibly take the lead? The conundrum is that agents in the financial sector face the same incentive problems as those in the real sector of the economy. Without the necessary changes in the real sector, agents would have to leave risk-adjusted returns on the table (Fisher-Vanden and Thornburn 2008). If they didn't have to, there would be no market failure on the road to the green transition in the first place. There is no free lunch.

Without effective government action,¹ “green preferences” can go some way towards easing this conundrum, as they weaken private incentives to maximize risk-adjusted returns. Hence the surge in “green investments” (Aramonte and Zabai 2021; Flammer 2021).

But the mere existence of such preferences is not sufficient to ease the conundrum. They need to be large and robust enough to make a material and lasting difference to the cost and availability of funding. And they should be universal. Otherwise, the green preferences of some in the financial sector would stimulate arbitrage forces or dubious, possibly even fraudulent, practices by others, negating the benefits.

An example of such a practice is greenwashing, i.e., instances of misrepresenting the CO₂ emission intensity of projects or activities in order to obtain cheaper financing or to market the final products more effectively. As the preference for green assets grows, so does the incentive to greenwash. Allegations of such instances have already prompted several investigations (Fletcher and Oliver 2022; The Economist 2021) and have led to policy initiatives designed to improve disclosure and its enforcement, both nationally and internationally (NGFS 2022).

¹ Taxes and subsidies on the financing of specific industries or the direct provision of financing could modify risk-adjusted returns just enough to align private incentives with the sustainability objective. Of course, as experience indicates, calibrating such interventions is not straightforward, and the interventions could be ineffective if they do not concur with clear signals from the real economy as to which types of production need to be stimulated or penalized.

More generally, evidence suggests that so far, financial markets have contributed little to steering the economy on a path towards sustainability (Elmalt et al. 2021). For instance, the premium at which debt instruments trade increases only marginally with the issuer's CO₂ emissions (Scatigna et al. 2021). More generally, even though “there is some evidence [that green finance has had an] impact on stock prices, bank lending conditions, and bank credit flows, [there is] no overwhelming evidence that this is moving the needle” (Weder di Mauro 2021).

RISKS TO FINANCIAL STABILITY

There is a consensus that the transition raises financial stability risks of its own (BCBS 2020; Bolton et al. 2021). But that analysis has not been comprehensive enough.

Fundamentally, financial instability arises when the financial and real sectors are out of sync, as exemplified by the financial boom-bust phenomenon. Financial expansions, on the back of aggressive risk-taking, fuel economic activity and overstretch balance sheets. In the process, asset prices and the volume of credit become increasingly disconnected from the capacity of the real economy to generate the corresponding cash flows. Since this disconnect is inherently unsustainable, the process goes into reverse at some point, generally abruptly and violently.

Seen in this light, the risks to financial stability linked to the transition are two-sided. One side relates to what has attracted attention so far – exposure to overvalued “brown” assets, which should lose their value (become “stranded”) as the transition proceeds. The concern here is that investors will either sleepwalk into “brown vortices” or act rashly, generating disorderly “brown runs” (e.g., Delis et al. 2018). But there is another side, which has received far less attention and is more similar to the familiar boom-bust pattern. This relates to exposure to either overvalued “green” assets or to assets that purport to be green; a “green bubble,” for short (Carstens 2021; Aramonte and Zabai 2021; Cochrane 2021 and Tett and Mundy 2022). The first side reflects an underestimation of the scope and speed of the transition; the second an overestimation.

The risk of a green bubble is material. In principle, private investors and lenders more generally have a clear incentive to ride bubbles, lured in by self-reinforcing returns. In some respects, policy and social pressures heighten the danger. With government measures in the real economy having so far fallen short of CO₂ commitments, the official sector has strongly encouraged green investment. Partly as a result, it is likely that private agents will expect some form of public support should things go wrong – a kind of “government put.” Social pressures, in turn, can reinforce emulation, or herding, further boosting the demand for green assets, even when the bubble

is recognized as such. The bursting of a green bubble would not only carry direct social costs but could also undermine the credibility of the transition process itself.

CONCLUSION

The primary role of private financial markets is to reflect the underlying condition of the real economy. Thus, it would be unrealistic to expect them to induce the green transition unless the right signals come from the real economy. Unrealistic expectations can set the financial sector up for failure and derail the transition. As a key channel for the reallocation of resources, the financial sector has an essential supporting role to play and must avoid adding to the transition risk.

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Jan Krahnén, Jörg Rocholl and Marcel Thum

Green Finance: From Wishful Thinking to Marginal Impact

KEY MESSAGES

- **The difficulty of establishing clear links between the origin of funds and their use calls into question the usefulness of ESG-oriented financing**
- **Active investors may exert a formative influence on a company's environmental and social actions, not least by accepting a personal reduction in earnings**
- **Passive investors will only be able to exert an influence if there are a large number of green investors and if markets are characterized by frictions and inefficiencies**
- **In the case of the state, there is no comparable way for investors to exert an influence, as budget planning remains the preserve of the legislature**
- **Combining private efforts towards green finance with public policies may render the former ineffective in achieving ESG goals**

“sustainable” exchange-traded funds (ETFs) at the top of their marketing lists, offering them to institutional and retail clients.¹

At first sight, this is quite a dramatic change for an industry that was traditionally single-mindedly focused on performance, for which returns and risk were the only factors that counted. However, much of the sustainability promises made by fund managers have turned out to be cheap talk, having only a minor impact on the real economy, if any at all. The main reason for our critical assessment is the difficulty of linking funding and investment in a manner that is both comprehensible and traceable.²

GREEN FINANCE CREDULITY

In this section, we present three arguments for why green finance as we know it and as it is widely practiced today is likely to be ineffective.³

Attributability: The Relationship between Assets and Liabilities in Corporate Balance Sheets

Think of a typical T account that represents the sources and uses of funds at firm X at the end of the year. Its balance sheet shows several asset classes: real estate, machines and equipment, accounts receivable, and cash. Among the assets are a wind power generator and a small coal-fired power plant that covers some of the firm's energy consumption. There are also several items on the right-hand side of the balance sheet: bank debt, accounts payable, and equity.

¹ “ESG” refers to environment, social, governance. We use the terms “ESG”, “sustainable”, and “green” as synonymous in the following.

² For a more comprehensive survey of the literature and a more extensive discussion of the various arguments, see Krahnén et al. (2021).

³ For a similar line of argument, see Wissenschaftlicher Beirat beim Bundesministerium der Finanzen (2021).

INTRODUCTION

Climate change is one of the most significant global challenges of our time. Massive joint efforts by policy makers, business leaders, academic researchers, and society are needed to combat the acceleration of climate change. The financial sector, in particular, is under increasing pressure from the public to play a role in solving the problem. The share of asset management services directed toward sustainable activities has risen steadily over the past 10 years. According to Morningstar, the total volume jumped significantly to \$1.7 trillion in 2020 (Jessop and Howcroft 2021). Global fund managers like Blackrock, Vanguard, and Fidelity, as well as leading asset managers in Europe, such as DWS, Union Investment, and DEKA in Germany, have placed “green” portfolio strategies and



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Foto: © Klaus Gigga

Now assume the firm issues a new bond as an intended substitute for the rather expensive bank loan. The prospectus advertises it as a “green bond” because it commits the proceeds to being used at all times for net-zero machinery and equipment, and in particular wind power generation. What can be said about the “green” role of the bond? Obviously, not much. First, the firm’s balance sheet contains several assets, some green and some, like the coal power unit, brown. Can we say that one particular funding source, such as the proceeds from the bond issue, is funding a particular item on the asset side, for instance the wind power engine? The answer is “no,” since there is no visible tie between the funding and the investment decision.

Additionality: Relationship between New Funds and Existing Assets

According to the Modigliani-Miller theorem, the value of a firm is disconnected from the type of financial instrument used for funding purposes. A real (causal) impact of the composition of liabilities on the value of the firm exists if and only if the use of a particular funding instrument would change the composition of assets held by the firm in a predictable way. If a particular financial instrument is said to be causally related to a specific investment, there must be a difference between the actual investment and the counterfactual investment. For the link to exist between a new type of financial contract (“green”) and a new type of machine (“ESG compliant”), some detectable, enforceable relationship is needed between the funds and their use.

That said, measuring additionality in terms of the characteristics of green investments or ESG criteria is a complex, if not impossible, task.⁴

Substitutability: Pricing of Securities in Markets

Even if the exact channel of impact cannot be identified, perhaps an aggregate effect on the firm’s cost of capital can be observed more generally. The standard argument in favor of a green premium, a “greenium,” that is, lowering firms’ cost of capital, relies on a price pressure effect in the market for corporate funds (Heinkel et al. 2001).

When “green” investors tilt their portfolios toward “green” companies, the cost of capital for the latter decreases, as does the expected portfolio return of “green” investors. The bulk of the early literature argues differently, in assuming an excess return for green investors. In a 2015 metastudy based on a sample of more than 2,000 academic papers, Friede et al. (2015) found that the large majority of studies reported positive outperformance. These findings

clearly contradict the above contention that a pro-green argument in the utility function of investors drives a greenium (a decrease in the firm’s cost of capital), resulting in an underperformance vis-à-vis conventional investments (Kapraun et al. 2021).

More recent empirical work by Pastor et al. (2021) reconciles the positive outperformance so widely found in the previous literature with the equilibrium underperformance (“greenium”) argument. The authors point to a hindsight bias in the form of a climate concern shock that would alter the economic behavior of consumers, producers, and the state in a way that would have been unpredictable in prior periods. Thus, given the recent increase in climate concerns, a climate-concern factor would explain the outperformance of portfolios comprising a set of “green” criteria.

PASSIVE AND ACTIVE INVESTORS

In the following, we will differentiate more finely between passive and active/activist investors.

Passive Investors

Pursuing a passive strategy means that the securities held in a portfolio are selected on the basis of some ESG index from a universe of existing stocks in the market. No direct influence on corporate investment policy is sought.

In a well-functioning capital market, the passive portfolio strategies of individual investors do not affect the overall attainment of ESG goals. In an integrated, information-efficient market, the diversion of investment funds into a subclass of potential investments will not affect the relative prices of investment alternatives, such as equities, or at least not permanently. Liquid funds from other investors, for whom the pursuit of ESG goals is irrelevant, will offset the diversion of funds.

The neutrality of passive investments vanishes when the demand for ESG stocks exceeds the supply at prevailing prices. If many passive investors appear in a market for ESG stocks, investor influence on the attainment of ESG goals becomes possible, even if these investors do not exert any influence on the management of the companies whose shares they hold. Investors change the relative cost of the capital of ESG companies compared to that of conventional companies, thereby creating incentives for conventional companies to transform into ESG companies. This change in the relative cost of capital arises from the large number of investors who prefer ESG investments and are willing to outbid other investors by forgoing returns. Investors might forgo returns, for example, because they derive greater non-financial benefits from ESG investment. As the cost of capital for ESG investments has fallen relative to the cost of capital for conventional investments, more ESG investment

⁴ A discussion of measurement issues relating to additionality in terms of climate goal achievement can be found in Greiner and Michaelowa (2003).

projects are becoming worthwhile, implying a positive net present value of cash flows for these projects. As a consequence, companies will transform themselves by altering their investment portfolio.

Activist Investment Strategies

To enforce ESG goals, an active investment strategy requires intervention at the individual company level. Unlike the passive ESG-oriented strategy, where many investors take a position via their portfolio decision, the investment here is directed primarily at the ESG companies, but it is also aimed squarely at conventional companies, with the intention of inducing higher ESG values.⁵

On the equity side, this intervention can take the form of voting in annual general meetings or joining the company's supervisory board. This intervention can take place via all financial instruments, bonds or equities, provided that the scale of investment is large enough to be perceived as a relevant investor. Usually, only institutional investors can achieve the required scale.

If the company previously followed a profit-maximizing path, then the intervention will push the firm off this path and lower its market value. After all, if an ESG-compliant change in corporate behavior, such as the installation of additional emissions filters, increases the value of the company, then a profit-maximizing firm would carry out this investment anyway, and no active investor would be required. As a result, an active investment strategy can indeed help achieve ESG goals, albeit hand in hand with diminishing returns (Oehmke and Opp 2020).

A number of publications address the broader, active influence that investors have on a company's strategy. For example, Landier and Lovo (2020) emphasize the importance of market frictions regarding the influence that ESG funds exert on companies. The authors show that the greater the frictions present in a capital market, the more impactful are the funds. They conclude that these funds can be most effective in less-efficient markets, such as with unlisted companies or small firms. The authors also show that the funds can amplify their effect by intervening in management decisions, for example, by imposing supplier restrictions on the company.

These findings on the particular importance of active investors in attaining ESG goals suggest that legislators should pay attention to the opportunities of active influence when regulating corporate governance. Giving more power to owners and the supervisory bodies vis-à-vis firm management could make a contribution to the attainment of ESG goals.

⁵ Note that in this case, the measurement problem regarding ESG goals is significantly smaller. First, it is not necessary to agree on a common taxonomy. Second, the different ESG goals do not have to be aggregated. All that is needed is that activist investors agree which ESG goals to pursue and how to control the management of their company in the pursuit of these goals.

Another implication of the above is that the impact via active investors may be larger for firms with ample room for improvement on an ESG scale. For instance, a coal-run power plant may earn "green" points, that is, it may reduce its emissions significantly when additional air filter systems are installed, and even exceed the regulatory requirements. Of course, the additional costs of the extra filter runs counter to the company's (short-run) profit interests. Gollier and Pouget (2014) use the catchy term "washing machine" for turning a "brown" firm into a "green" one and provide conditions when investments in non-responsible companies can generate positive abnormal returns in the long run.

GREEN FINANCE AND GOVERNMENT POLICY

Interaction of Government Policies and Private Investment Strategies

If green finance goes beyond accounting tricks and really leads to a reduction in a company's CO₂ emissions, investors' actions constitute a private contribution to a public good (mitigation of global warming) (Cornes and Sandler 1986). It is financed by the green investor's lower return. It has been well established that in general, private contributions lead to an underprovision of the public good. A welfare-maximizing government could achieve an efficient solution, but a (tax-financed) government provision usually crowds out some, but not all, private activities. Some private contributions remain despite comprehensive government activities, as investors enjoy a warm-glow utility from their own contributions, i.e. they draw a personal benefit from doing good to society (Andreoni 1990).

Somewhat surprisingly, in the literature on green finance, the government is almost entirely absent as a crucial player.⁶ This absence might be justified if private and government activities took place in separate spheres. Then the private provision would simply top up whatever the government had provided. However, this is certainly not the case. Unfortunately, there is no guarantee that more green investors would really make the economy greener. A formal analysis of the interaction shows that, on the one hand, an increase in the number of green investors leads to additional (warm-glow) contributions to the public good. This effect per se makes the economy greener. On the other hand, a greater number of private contributors also enhances the crowding-out effect, which induces the government to optimally provide less of the public good (Lamprecht and Thum 2022).

⁶ In a recent paper on green finance, Hakenes and Schliephake (2021) make use of this warm-glow mechanism. They formulate the model in terms of a disutility (guilt) from investing in polluting production.

The Case of Green Government Bonds

ESG-guided investments play an important role outside the private sector too. The issuance of so-called “green government bonds” has increased significantly in recent years. In September 2020, the Federal Republic of Germany also issued green government bonds for the first time. An issue volume of 6.5 billion euros was matched by a demand for 33 billion euros. One special aspect of these securities is that they are so-called “twin bonds,” whereby a green security with the same maturity and coupon is issued alongside a conventional federal security. The green bond is the one twin that replaces part of the auction volume of the conventional bond that is the other twin. This issue design is intended to ensure that green government bonds can be exchanged for conventional government bonds at any time and thus have comparable liquidity. Their design also ensures that green government bonds do not place higher costs on the federal government as the issuer (of course with no higher returns for investors either).

On the expenditure side, previously planned government spending that is compatible with green goals offsets the proceeds from the issue of green government bonds. This kind of spending includes energy-efficient building refurbishment, the e-car purchase premium, and public transport. In line with this policy, the German Ministry of Finance has asked all ministries to look for expenditures in their budgets that are compatible with green goals. Accordingly, the maximum volume of federal green bonds is derived from the volume of existing spending in the federal budget that is compatible with green goals. This should not imply an expectation on the part of investors that the government will specifically use their funds to do more to achieve ESG goals. Green government bonds do not per se have a higher and more attributable ESG impact than conventional government bonds. In this respect, they are no different from a conventional government bond.

There is an important difference between corporate and public financing: While companies raise both equity and debt capital, governments only act as debtors on capital markets. Equity investors, in particular, have the opportunity to exert influence on the management of these companies by strongly pursuing ESG goals or, in extreme cases, even replacing management. This possibility, however, does not exist in the case of sovereign financing. Rather, the pursuit of ESG goals is subject to political decision-making and thus to the parliamentary process. The ability of capital markets to influence the attainment of ESG goals is thus significantly lower with respect to governments than it is with respect to companies, because investors as a group of actors do not – and indeed should not – have a privileged voice in the political decision-making process. The role that active

investors can play with respect to companies falls to the electorate in the case of governments.

POLICY CONCLUSIONS

These fundamental considerations give rise to a number of recommendations for a financial policy that is geared toward ESG criteria. The promotion of real economic goals through guidelines for expenditure financing is only conceivable under restrictive conditions. We highlight the following important arguments:

The difficulty of establishing clear links between the origin and the use of funds calls into question the usefulness of ESG-oriented financing.

1. The key yardstick for ESG-oriented financing should be the expected changes in the real economy, e.g., in environmental quality.
2. A change in the real economy may occur if private investors actively exert a formative influence on a company’s environmental and social actions, not least by accepting a personal reduction in earnings.
3. In principle, a real economic effect is also conceivable in the case of passive investment, but only if the number of passive investors is large and if the markets are characterized by specific frictions and inefficiencies.
4. There is no comparable way available to investors to exert influence on the state, as budget planning remains the sole preserve of the legislature.
5. Attempts to combine private efforts with public provision need to be taken into consideration. But before recommending more private efforts towards green finance, we have to be sure that this will really bring us closer to our ESG goals.

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Transition Finance and its Relationship to Green Finance

To avoid catastrophic effects of climate change and to stabilize temperatures globally, it is critical for economies and organizations to rapidly implement plans to decarbonize. One way to incentivize rapid decarbonization is to provide financial resources to organizations at lower cost but conditional on their alignment with a commitment to rapidly decarbonize. The use of finance in this manner is colloquially referred to as “transition finance.”

Interest in transition finance has grown among businesses and other organizations due to the need to rapidly scale the move towards sustainable practices. However, there has been much confusion about the nature and relationship of transition finance to other forms of sustainable finance such as green finance. In this article, I will discuss how to best understand transition finance and to discuss its relationship with green finance from a policy perspective. By illustrating the commonalities and distinctions between both approaches to sustainable finance, it is hoped that policymakers can implement ways to increase the rapid adoption and credibility of environmental and socially sustainable practices both at the firm and economy-wide level.

There are three major takeaways from this article. First, a policy-relevant definition of transition finance is one that incorporates the addressing of both environmental and social issues simultaneously and within a specified time frame. Second, while green finance and transition finance are concerned with accounting for environmental factors in the providing of funding, transition finance is distinguished by its inclusion of social issues as an area of concern. Third, policymakers need to focus their efforts on ensuring that transition finance activities and products credibly deliver what they promise. Policymakers should focus their efforts on validating transition finance activities and products through standard setting and developing methods and metrics to assess sustainable performance.

DEFINING TRANSITION FINANCE

Much of the confusion between transition finance and green finance arises from a lack of clarity on how the former is defined. This is not a unique problem; many areas of sustainable finance are criticized for lacking a clear definition. This has had the unfortunate effect of making it hard to understand what distinguishes various groupings of sustainable finance activities both among policymakers and the public. To allow for a focused discussion of the relationship between green and transition finance, I will identify the definition of

transition finance for this article after reflecting on how it has been defined in the past.

Initial definitions of transition finance were varied and typically reflected the unique context in which the funding provided was deemed to assist “sustainable transition.” International organizations would tend to define transition finance with a focus on promoting the achievement of the Sustainable Development Goals (SDGs). For example, the OECD (2019) defines transition finance as the optimization of the access to finance for sustainable development and to avoid major financing gaps or socio-economic setbacks. In contrast, organizations and financial firms have traditionally stressed a definition of transition finance that focuses on organizational shifts to adopt environmental and sustainable projects that address climate-related risks (e.g., Klier et al. 2020 and ICMA 2020). An example of a definition that is illustrative of this approach would be the defining of transition finance as a form of risk mitigation; it is a type of funding that improves the underlying performance of the organization through a reduction in its transition risk exposure (Tandon 2021). Thus, to achieve a successful “transition,” an organization is to identify ways to address and/or mitigate transition risk exposure. With respect to finance, transition risk could be addressed using financial markets and instruments

KEY MESSAGES

- Both green and transition finance aim to promote improvements to environmental outcomes of organizations
- Transition finance is best defined as financial activities that are conditional on entities achieving contextually relevant environmental and socially sustainable criteria within a limited time frame
- In contrast to green finance, transition finance recognizes the importance of addressing social issues along with environmental issues
- Policymakers should focus on making greenwashing within transition finance and green finance more costly
- As societies begin to seriously speed green transition plans, the role of transition finance will continue to grow



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to hedge transition risk and/or incentivize risk management through contractual terms specifying a commitment to decarbonization.

Further developments to the definition of transition finance sought to explicitly stress the conditional linkage between environmental and social sustainability performance and any funds provided from transition finance activities. Linking the achievement of environmental and socially sustainable criteria also has the effect of connecting transition finance explicitly to the SDGs and the core aspects of sustainable finance broadly. Such linkages have been theorized to incentivize transition adoption – should the financial instrument be designed appropriately – to reduce the cost of capital when sustainability criteria are achieved (e.g., Caldecott 2022). This approach, however, has been criticized as resulting in transition finance to be no more than a variant of traditional finance. It is argued that financial instruments can be identified as “transition finance” so long as contractual terms within the financial product in question refer to environmental and social sustainability criteria (Tandon 2021).

More recent definitions of transition finance have begun to include a temporal component that is related to major environmental sustainability objectives. An example of this shift is the most recent OECD definition of transition finance (OECD 2022). This work defines transition finance as “... finance deployed or raised by corporates to implement their net zero transition, in line with the temperature goal of the Paris Agreement and based on credible corporate climate transition plans”.

While the reference to achieving net zero transition indicates a linkage between the providing of funds and the attainment of environmental and socially sustainable objectives, it is implied that there is an endpoint to the provision of this kind of finance. When organizations realize a net zero transition, transition finance would no longer be needed. This can be contrasted with financing that seeks to maintain longer term sustainable practices of organizations such as green bonds that can be issued and renewed for longer time horizons.

An important takeaway for policymakers from this discussion is that there is an emerging consensus around a general view of what transition finance is. I would like to propose a definition of transition finance for the remainder of this brief that realizes this development. Transition finance is best defined as financial activities that are conditional on entities achieving contextually relevant environmental and socially sustainable criteria within a limited time frame. Such a definition provides important flexibility in allowing policymakers to determine what may or may not be environmentally or socially sustainable for certain entities while simultaneously stressing the need to achieve transition commitments within a short period of time.

THE RELATIONSHIP BETWEEN GREEN FINANCE & TRANSITION FINANCE

The previous discussion of what transition finance is allows for a more detailed discussion about its relationship with green finance. It is common for both green and transition finance to be used interchangeably to describe various financial activities and products. Despite this common usage, it is important for policymakers to recognize that while both share some common attributes, there are important distinctions between both subsets of sustainable finance. The failure to recognize these distinctions has important policy implications when trying to ensure integrity and credibility of green and transition finance markets and products, respectively.

The main reason why it is common to view green and transition finance as one and the same is because both are a form of sustainable finance. Sustainable finance is defined as looking at how finance interacts with economic, social, and environmental issues (Schoenmaker and Schramade 2019). Economic issues relate to investing impacts on economic conditions at local, national, and global levels. Social issues relate to rights, well-being, and interests of people and communities. Environmental issues are those which are related to the quality and functioning of the natural environment (UNEP 2016).

Both green and transition finance are best understood as subset approaches to finance within the broader sustainable finance ecosystem. Both green and transition finance are related through the mutual incorporation of environmental factors in finance and financial activities. Green finance has been framed as any structured financial activity that has been created to ensure a better environmental outcome in a broader sense beyond simply climate change (World Economic Forum 2020 and UNEP 2016). Like green finance, transition finance concerns itself with all aspects of environmental issues involved in the transition to sustainable economic systems and practices. For example, green bonds as a financial instrument could *prima facie* be viewed as either a type of green finance or a type of transition finance. This is because this financial instrument is focused on promoting better environmental outcomes for issuers.

However, transition finance is distinguished from green finance by virtue of its incorporation of social issues. An example of this inclusion is shown in the notion of a Just Transition; the equitable distribution of the costs and benefits among stakeholders affected by the transition to sustainable economic practices (EBRD 2022 and International Labour Organization 2015). Within this framework, it is widely recognized that funds provided to organizations must also account for the likely social impacts of the transition and account for them in a fair and equitable manner. These types of social considerations are not usually considered within green finance because their scope

tends to be limited to producing sustainable environmental outcomes, such as reduction in CO₂ emissions. Returning to the green bond example, the bond in question could be considered a form of transition finance should there be covenants within the bond that require firms to meet social sustainability metrics in addition to environmental ones. Should these not be included, the green bond should be viewed as a type of green finance instead.

It is important for policymakers to understand that while green finance and transition finance share a focus on environmental issues, they are not the same type of sustainable finance activity. This distinction is of increasing importance as policymakers shift towards hardening benchmarks for decarbonization. Conditioning funding on targeted environmental outcomes such as greenhouse gas (GHG) emissions does not necessarily mean that firms are also meeting socially sustainable metrics.

A good way to emphasize this distinction is by way of an example. Suppose funds were raised to allow an energy company to retire coal power plants earlier than expected. While such retirement would produce reductions in greenhouse gas emissions, such early retirement may result in the redundancy of many workers and may affect the wider society that supports such a large industry. Transition finance would attempt to address the social implications of decarbonization activities along with the environmental impacts. In this example, transition finance would seek to allocate funds to ensure that workers and regions are compensated for the loss of an important industry. In contrast, green finance would not be concerned with this social element and would instead focus on raising funds to allow for the rapid retirement of the powerplant regardless of the social effects.

CREDIBILITY OF TRANSITION FINANCE

Another way that green finance and transition finance are often related to one another is through the common issue of credibility. At present, it is very difficult for policymakers and the public to credibly determine what green or transition finance activities are legitimate activities from those that are not. This phenomenon is known as “greenwashing”: the active misleading of consumers, the public, and policymakers of the environmental performance and/or benefits of a product or service (Delmas and Burbano 2011).

Greenwashing is a natural result of the explosion of the green finance market. In 2021, the global sustainable finance market passed over 1 trillion USD in total size representing a 20-fold rise since 2015. Sustainable debt markets issuance rose to over 1 trillion USD in 2021 alone and was driven by sharp increases in green bond issuances (Toole 2022). Sustainable equity capital markets have witnessed similar increases with the amounts raised in 2021 totaling a record of 48 billion USD. The sustainable finance market has

slightly cooled in 2022 with sustainable debt and equity returning to immediate post COVID 2021 levels (Jones 2022).

The growing size and amount of sustainable finance markets and instruments provides an incentive for greenwashing to occur. There is a clear underlying incentive for firms to misrepresent their sustainability metrics and transition paths for the sake of witnessing larger increases in firm value through reduced cost of capital without providing any fundamental changes to the sustainability of the business.

Further exacerbating the greenwashing problem in both green and transition finance are several unique barriers to providing credible products to the market. At present there is a lack of clarity and coordination on the guidelines, standards, and definitions of activities that are considered transition finance. Moreover, there are unique difficulties in measuring sustainable performance and relevant key performance indicators that demonstrate when organizations have achieved sustainability criteria (OECD 2022). Not only is it difficult to identify what a sustainable financial product is, but it is also difficult to verify whether an organization has met their commitments.

Both green and transition finance are susceptible to greenwashing. However, unlike green finance, the effects of greenwashing actions in transition finance may be more severe. By its very nature, transition finance provides funding to assist existing organizations that may be engaged in activities that are currently deemed environmentally or socially unsustainable. Given the underlying incentive to cheat, already unsustainable businesses may be able to lower their funding costs through greenwashing actions. Not only have the funds provided failed to transition the business towards more sustainable practices, but it may have the effect of further lengthening their use of unsustainable practices through reduced cost of capital. This ultimately presents a serious threat to the achievement of decarbonization pathways should all firms follow similar actions with transition finance funds.

In light of these main issues, there are a number of avenues through which policymakers can improve the integrity and credibility of both green and transition finance products and activities. Policymakers can focus on the further development of standards and guidelines to identify what the transition finance products and activities are that are nationally and internationally accepted. An example of standard development is the EU taxonomy for sustainable finance activities. This taxonomy provides companies, investors, and policymakers with appropriate definitions for economic activities that can be considered environmentally sustainable (European Union 2022). The European Commission (2022) has already recommended extending this taxonomy to include transition finance activities as well. It is generally rec-

ommended that this work continue to be extended in other jurisdictions.

Policymakers can also make a concerted effort to further establish key performance indicators that can both accurately measure and assess whether organizations have truly met their stated environmental and socially sustainable commitments. Accounting organizations have taken the lead in this regard. For example, the International Financial Reporting Standards (IFRS) have recently launched the International Sustainability Standards Board (ISSB) to deliver a comprehensive global baseline of sustainability-related disclosure standards to provide investors and other capital market participants with information about companies' sustainability-related risks and opportunities (IFRS 2022). Similar standards are being introduced by central bank authorities through the Network for Greening the Financial System (NGFS) (NGFS 2022). National level policymakers and regulators should also coordinate to develop similar standards within their jurisdictions and contribute their experiences with others to identify best practices for sustainability disclosures over time.

Finally, policymakers should develop ways to incentivize credible transition plan adoption by improving the benefits organizations can witness by adopting credible transition plans while increasing the costs to firms engaged in greenwashing activities. An illustration as to how policymakers can increase the benefits for adopting credible transition plans is the recently launched transition plan disclosure framework by the Transition Plan Taskforce. This guide provides clear recommendations as to how firms can formulate, implement, and monitor an effective transition plan (Transition Plan Taskforce 2022). As a form of best practices, this should reduce the cost to implement a transition plan, thereby maximizing any potential "greenium" i.e., a lower cost of capital, organizations may witness from adopting transition finance products and activities. Simultaneously, policymakers should introduce more severe penalties for greenwashing as well as adopt a more active role to monitor green finance markets for such misrepresentation.

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Gas and Nuclear Power as Transition Technologies – What does this Mean for Investments?

INTRODUCTION

One of the three principle objectives stipulated in the U.N. Paris Agreement (United Nations 2018) is to make “finance flows consistent with a pathway towards low greenhouse gas emissions and climate-resilient development” (Paris Agreement, art. 2(1)). Such and similar statements of intent form the backdrop of many “green finance” policy initiatives around the world that seek to align the allocative function of financial markets with global climate targets. The European Union has emerged as an ambitious regulatory pioneer in this area, hoping that a “Brussels effect” (Bradford 2020) might inspire similar endeavors in other jurisdictions. The Action Plan on Financing Sustainable Growth set out a far-reaching agenda to “green” the financial system (European Commission 2018). As its primary tool, contemporary EU green finance regulation relies on an abundance of disclosure obligations. Part of this broader transparency framework is the EU Taxonomy, colloquially referred to as the bloc’s “labeling scheme for green investments.”

In 2022, the Commission designated certain activities in fossil gas and nuclear energy as eligible to qualify as “green” activities under the Taxonomy. Public outcry followed: Critical voices pointed not only to the environmental but also the geopolitical concerns that are at odds with the Commission’s decision. The classification certainly has an important symbolic dimension. Symbolism aside, however, it should not be overlooked that the Taxonomy is first and foremost an instrument of green finance policy. It does not impact climate or energy policy directly. The prospective effects of the Commission’s controversial classification thus depend on what the Taxonomy status of gas and nuclear power means for investment flows.

KEY MESSAGES

- **So far, the applications of the Taxonomy are purely for transparency and disclosure purposes**
- **Professional investors and regulators instead rely on more advanced and context-specific metrics, such as their own ESG methodologies and cockpits**
- **Therefore, the controversial Taxonomy classification of gas and nuclear power will not have a major impact**
- **Green finance policies are no substitute for restrictive environmental regulations such as cap-and-trade schemes or outright prohibitions of certain activities**

Currently, the Taxonomy is only leveraged as a disclosure and informational tool. Its primary function is to generate one highly condensed piece of information, which should be relatively uninteresting for seasoned investors. Many of them have already established their own ESG or sustainability cockpits and methodologies to obtain custom-tailored assessment of investment opportunities. It is hard to imagine that they would ditch these resources and rely exclusively on the Taxonomy. The main audience for Taxonomy-based information is unsophisticated investors at the end of the investment chain, such as retail investors in ESG-branded mutual funds. The main reservation one may have with regard to the Commission’s classification is that Taxonomy-based disclosures targeted at unsophisticated investors lump together gas and nuclear investments with other “green” investments (e.g., renewables) – which would arguably result in more, not less greenwashing, contrary to the Taxonomy’s objectives. But a closer look



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reveals that this concern is largely a red herring: For virtually all Taxonomy applications, contentious gas and nuclear power exposures will have to be disclosed separately from other “green”-labeled activities.

So long as the Taxonomy is only about transparency, the energy transition is unlikely to hinge on or be slowed by the labeling of fossil gas and nuclear energy under this framework. This might change, of course, once the Taxonomy is used as a basis for financial policies with a more direct steering effect that go beyond mere disclosure – such as tax benefits or bank capital requirements. However, whether there will ever be such policies remains unclear at this point. For the time being, the Taxonomy treatment of gas and nuclear power is, at best, a second order concern for the reorientation of capital flows towards sustainable activities.¹ The critical question remains to what extent market-based green finance policies can achieve the overarching objective in the first place.

BACKGROUND: THE SIGNIFICANCE OF THE EU TAXONOMY FOR GREEN FINANCE

Basic Idea

At its core, the EU Taxonomy Regulation (TR) establishes criteria for “determining whether an economic activity qualifies as environmentally sustainable” by means of a three-pronged definition: An activity must make a substantial contribution to one of six environmental objectives (most prominently, climate change mitigation), it must not harm any of these objectives, and it must observe minimum human rights safeguards (TR, art. 3(a)-(c)). For the first two elements, the Regulation tasks the Commission with adopting legally binding “technical screening criteria” that an activity must observe to deserve the Taxonomy label (TR, art. 3(d), 19).

By “label,” we refer to a quality signal that compresses one or more pre-defined objective and complex indicators into a single piece of information, based on a clear, technical definition or a specific methodology. By design, labels explicitly or implicitly encode an evaluation or judgement – in the case of the Taxonomy, this judgement is binary: an activity either meets the criteria and is thus “green” (“environmentally sustainable”), or not. The counterpart to the information category of “labels” are “raw data,” i.e., uncompressed information that allow economic actors to conduct their own assessment. For example, for the activity of manufacturing passenger cars, tailpipe emissions would be a (continuous) raw data point. Under the Taxonomy, the chief requirement

for receiving the “green” label for that activity is that the tailpipe emissions be less than 50gCO₂e/km, and, from 2025, zero.

In the financial context, labels can be applied at different levels of aggregation (for details, see Steuer and Tröger 2022a): at the level of individual economic activities, at the level of companies (which often entertain many activities with different environmental footprints), and at the level of portfolios of financial instruments issued by those companies (for example, the investment portfolio of a mutual fund). The basic idea of the Taxonomy is to provide some definition of “greenness” already at the activity level, which can then be used to compute the degree of greenness at higher levels.

What Taxonomy is Used for in Union Law

Currently, EU green finance regulation leverages the Taxonomy exclusively as a reference point for certain disclosures.

At the issuer level, companies subject to disclosure mandates under the Non-Financial Reporting Directive (NFRD) and its successor, the Corporate Sustainability Reporting Directive (CSRD), have to report, on an annual basis, on the Taxonomy classification of their individual activities (TR, art. 8). To use a simplified example, a car manufacturer with both a combustion engine business with high fuel use and an electric vehicle business line would have to disclose how its revenues, capital expenditures, and operating expenditures break down to these business lines and if they comply with the Taxonomies’ technical criteria – which in the example will likely be true for the electric business, but not the combustion engine business. From this activity level disclosure, investors can then obtain the taxonomy quotas at the issuer level mentioned above.

Taxonomy-based disclosure obligations also exist at the portfolio level for certain ESG-branded investment products, such as (purportedly) “green” mutual funds or ETFs tracking “green” indices. For these products, dedicated templates need to indicate ex ante what minimum Taxonomy quota the product will achieve (i.e., portfolio-weighted issuer-level quotas), and report ex post on actual Taxonomy quotas. Prudential regulation will likely impose a similar disclosure requirement on large banks for their credit portfolios, which would go beyond issuer-level Taxonomy disclosures that are required from banks under the NFRD/CSRD.

Another likely use case for the Taxonomy label will be the EU Green Bond Standard (European Commission 2021). Such bonds entertain “use of proceeds”-clauses that seek to earmark funds raised for specific (green) activities, although legally and economically the funds were sourced at the issuer level. Under the EU Green Bond Standard, bond issuances could be labeled as EU Green Bonds if the proceeds are reserved to fund Taxonomy-compliant projects.

¹ We do not intend to take a normative position here on which role nuclear and fossil gas should play in the as a matter of substantive environmental, energy, or foreign policy. Our point is simply that, from a law and finance perspective and under currently applicable regulations, any “misclassification” of gas and nuclear power under the Taxonomy is unlikely to hurt much.

What the Taxonomy is not Used for

For a sober analysis, it is equally important to avoid common misperceptions and appreciate what the Taxonomy is not used for under applicable Union law.

First of all, the Taxonomy is not employed to label issuers. There is no classification system for “green” issuers under European green finance rules. The role of the Taxonomy exhausts itself in the disclosure of a Taxonomy quota without any further evaluation. Company-level ratings are issued by private ESG rating firms. Whether or not these firms rely on Taxonomy-related information in their rating methodology is governed by market forces, not Union law. The Taxonomy is also currently not used to apply blunt labels to portfolio-based investment products (mutual funds, etc.) by classifying the product itself as “green” or “not green.” Plans along those lines initially existed: The EU Ecolabel for Retail Financial Products was intended as a binary (and voluntary) label in reference to portfolio-level Taxonomy quotas (JRC 2021). However, the Commission has not followed through with these plans to date. The so-called “dark-green” and “light-green” fund categories under the Sustainable Finance Disclosure Regulation (SFDR) arguably have some labelling function as well, but this classification does not hinge on the Taxonomy (Steuer 2022). The same was true for BaFin’s proposal for a national sustainable fund labeling standard (Steuer and Tröger 2022b) and is true for current proposals for ESG-fund naming guidelines at the European level (ESMA 2022).

Neither does the Taxonomy play any significant role in the current regulatory framework for prudential supervision. Taxonomy criteria are not used in the computation of bank capital requirements. To be sure, applicable regulations instruct the European Banking Authority (EBA) to furnish a report on “whether a dedicated prudential treatment of exposures related to assets or activities associated substantially with environmental and/or social objectives would be justified” (CRR, art. 501c). But this report is only due in June 2025, and even if regulators were to adopt rules on “green” capital requirements at some future date, it is very unclear whether such requirements would be based on the Taxonomy label or on other metrics (such as raw data on greenhouse gas emissions). Absent such rules, the Taxonomy might become relevant only indirectly, when bank supervisors rely on it in the course of ongoing supervision. But supervisors’ official communications often do not really consider the Taxonomy at all (see e.g., ECB 2020, 2022a), and where they do, they are relatively cryptic as to what useful role the Taxonomy might play for prudential purposes (see e.g., EBA 2021). In a recent report, the EBA conceded that the Taxonomy criteria are simply not designed as a risk indicator (EBA 2022). And in its 2022 climate risk stress test, the ECB Bank Supervision did not rely on Taxonomy data, but on rough

sector classifications and issuer-level emissions data (ECB 2022b).

Gas and Nuclear Classification

From the beginning of the Taxonomy project, there were significant controversies as to what extent and under which conditions nuclear- and gas-related activities should be eligible for a “green” classification. The long political struggle resulted in technical screening criteria for these activities – not included in the 2021 Delegated Regulation, but tacked on to the so-called Complementary Climate Delegated Act (TR-CCDA) in 2022 – that reflect a horse trade between those Member States with heavy reliance on nuclear energy in the transition (France) and those who see a more prominent role for natural gas as a transition technology to substitute coal: both activities can be considered “green” under the Taxonomy, although this label does not apply automatically and is subject to several conditions which highlight the importance of nuclear waste disposal and the role of gas as a transition technology. Several proceedings have been brought before the European Court of Justice by NGOs, and also by Austria in its capacity as a Member State, to challenge the compliance of the classification criteria with the higher-ranking three-pronged sustainability definition of the Taxonomy Regulation.

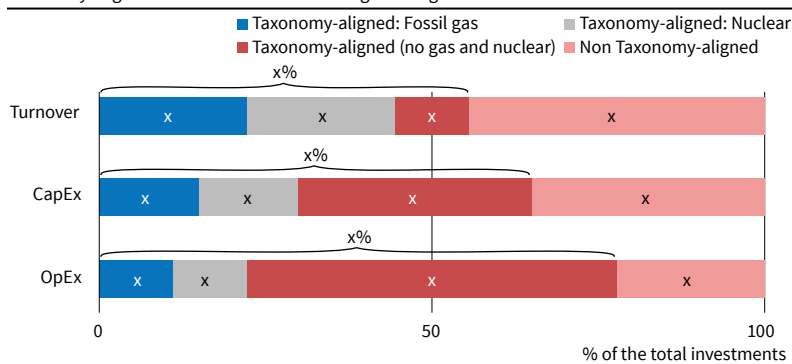
Gas- and nuclear-related activities receive a very special treatment under the rules that govern Taxonomy use cases. At the issuer level, the TR-CCDA introduced two separate reporting templates specifically designed to disaggregate nuclear- and gas-related activities. Therefore, even unseasoned investors should be able to subtract these controversial positions from issuer-level quotas. In a similar fashion, portfolio-level disclosure rules under the SFDR will be revised to ensure that nuclear- and gas-related activities are reported separately; Figure 1 illustrates this approach. For the pending draft of an EU Green Bond Standard, the European Parliament has recently proposed the addition of specific disclosures and disclaimers in case a Green Bond funds gas or nuclear activities (Council of the European Union 2022).

FOR WHOM DOES THE TAXONOMY MATTER?

The Role of Mandatory Disclosure

Climate-related transparency mandates may help shift investments into “green” economic activities by lowering the cost of capital for such activities relative to “dirty” activities (e.g., Steuer and Tröger 2022a). For this mechanism to unfold, investors need to prefer investments in “green” activities. They may do so for financial reasons, if they seek to minimize transition risks (e.g., Bolton and Kacperczyk 2021), or out of moral convictions and other non-financial motivations (e.g., Pástor et al. 2021). Mandatory dis-

Figure 1
Disaggregation of Gas and Nuclear from Taxonomy Quotas in SFDR Disclosures
 Taxonomy-alignment of investments excluding sovereign bonds



Source: JC-ESAs 2022.

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closure rules are needed if markets fail to produce high-quality, standardized information that allows investors to compare investment alternatives. Markets tend to underproduce such information because of the public good characteristics of standardization and enforcement (see e.g. Christensen, Hail and Leuz 2021). Under these circumstances, regulation can help overcome information asymmetries, and thus aid the allocation of capital in line with any “green” investor preferences. In addition to the cost-of-capital channel, transparency initiatives in the financial markets may also contribute to environmental objectives via other indirect channels, e.g., by raising public awareness of the underlying issues, easing the benchmarking of environmental performance, or triggering environmentally desirable responses from non-investor audiences such as consumers, the media, or NGOs.

Importantly, in practice transparency-oriented green finance policies come in various forms, which require the disclosure of various types of information relevant to different audiences at different locations in the investment chain. Besides Taxonomies and other labels, professional investors also and predominantly demand the disclosure of standardized and audited raw data, such as descriptions of climate targets, metrics of corporate emissions, or other environmental impact data at the firm-level. Therefore, the EU Taxonomy constitutes only a relatively small element of a much larger transparency framework. The actual backbone of EU green finance legislation is not the Taxonomy, but the CSRD framework, which will require companies to report a vast array of raw data points on the environmental footprint of their activities, under standards akin to those used to govern financial accounting and reporting.

Professional Investors

We do not expect that sophisticated, institutional investors and their information intermediaries (rating agencies) will rely heavily on a government-sponsored label like the Taxonomy classification or quota in their allocative decisions. Rather, institutional investors and

asset managers will base their capital allocation on more granular raw data and evaluate the climate-related risks they would run with an investment, the undesired climate impact, etc., themselves.

Green bonds, which are often marketed to institutional investors, are a case in point. These investors can be expected to “look through” the taxonomy label and buy nuclear/gas bonds only if they like the underlying business model, and if they do, they will buy such use-of-proceeds bonds regardless of their Taxonomy classification anyway. Even insofar as sophisticated investors may rationally consider the Taxonomy classification as an indicator for lower transition risk, they can be expected to understand not only that the underlying political compromise is inherently fragile and can be revoked at any time, but also that the green finance label does not shield “dirty” activities from regulatory restrictions imposed in the pursuit of environmental or energy policies. For instance, the price for carbon emissions in cap-and-trade schemes is set independently from the Taxonomy designation of gas power production. Once again, the pivotal risk factor that drives asset valuation and thus investment decisions will be assessed in a “look through” and not in blind reliance on the Taxonomy classification.

Retail Investors

An important reason why sophisticated investment intermediaries may allocate capital to assets that have high Taxonomy quotas or are designated as “green” by the EU Green Bond Standard is the marketability of such products in retail markets. Predominantly Taxonomy-aligned or Green Bond-rich portfolios allow asset managers to turn to retail investors and advertise their products as particularly sustainable. Unsophisticated retail investors will typically not possess the knowledge and resources to “look through” the government-sponsored label. Importantly, however, Taxonomy alignment needs to be broken down and reported separately for nuclear and gas power. This disaggregating reporting requirement takes much of the sting out of looming deceptive disclosures. If Taxonomy alignment and quotas could be reported without further qualification, energy companies that rely heavily on gas and nuclear power production could indeed look just as sustainable as providers of wind or other renewable energy. Yet, the regulatory framework bars exactly such undifferentiated labeling.

In fact, the separate reporting requirement may have a chilling effect on retail investments, despite transition technologies receiving a positive Taxonomy classification: Retail investors may not be in a position to replicate and question the quality signal, but they may dislike gas or nuclear energy production no matter what. Learning that certain companies or portfolio products have a relatively high proportion of such activities may prevent them from investing, even though these activities are technically Taxonomy-aligned.

CONCLUSION

The controversial Taxonomy classification of gas and nuclear power will not have a major impact as long as the applications of the Taxonomy are purely for transparency and disclosure purposes. In the future, fiscal regulators might, of course, rely on the Taxonomy to determine eligibility for certain tax benefits or other subsidies, or financial regulators might use this Taxonomy framework as the foundation of a new regulatory framework, namely by linking regulatory capital requirements or investment restrictions directly to the Taxonomy. Should gas and nuclear energy activities receive no “special treatment” under such frameworks, there would clearly be more direct incentives for investors to tilt their investments towards those technologies. But to what extent the broader regulatory architecture will be linked to the Taxonomy remains uncertain at this point. This is especially true in light of the issues we discussed above: Like professional investors, ambitious regulators might wish to “look through” the blunt Taxonomy classification and instead rely on more advanced and context-specific metrics.

Our analysis reveals that within the current EU green finance framework, the curious status of gas and nuclear technology does not matter too much. One can reasonably dislike this decision as a matter of political symbolism and yet be in favor of the transparency-oriented green finance approach in general; one can even be skeptical of the Taxonomy approach in general and still hold a favorable view on the raw data-oriented disclosure mandates under the CSRD. Needless to say, the idea of affecting climate outcomes via financial regulation is, of course, a second-best solution in the first place: No matter how comprehensive and ambitious the disclosure mandates and risk management requirements, green finance policies are no substitute for restrictive environmental regulations such as cap-and-trade schemes or outright prohibitions of certain activities. Green finance alone will most likely not save the planet, whether or not some of the “green” money flows to gas and nuclear activities.

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The Signal in the Noise

INTRODUCTION

ESG rating agencies have been under severe bombardment lately. Criticism concentrates on several fronts: what should be measured; how should it be measured; the unfortunate opaqueness of the procedures; and the severe discrepancies across different ratings for any given firm. Some voices have called for a full-blown overhaul. In fact, it is rare to find a week without someone writing a criticism of ESG ratings and ESG rating agencies in particular. Critique from politicians, all the way to John Oliver, reflects that people are dissatisfied with the current situation. Indeed, it could be said that parts of the right and left of the political spectrum have found an intersection, albeit for different reasons, in their disapproval of ESG rating agencies. Notably, *The Economist* (2022) has recently argued in its cover story that financial institutions should retreat from ESG to simply focus on the environmental dimension or even more specifically, just on carbon emissions – stating as a reason that there is too much noise in the signal.

We argue that abandoning ESG would throw the baby out with the bathwater. Firms' ethical behavior is essential to the health of economies, societies, and the natural environment. ESG, however flawed, is the current best effort to measure the ethical behavior of firms. Deployed in a more transparent manner, ESG data can empower investors and other stakeholders to hold firms accountable. Our research suggests that ESG data can be an important source of information for investors, and this will be even more true as we elevate the signal in the noise.

First, we document the problem, i.e., the disagreement. Indeed, the scores from different ESG rating agencies exhibit low correlations. Figure 1 presents the score of firms for Sustainalytics in the horizontal axis – the scores have been rescaled to make them comparable (i.e., normalized to have mean zero and variance 1); and the vertical axis represents the rescaled scores of the same firm in the same year given by other rating agencies (S&P, Moody's, MSCI, Refinitiv, and KLD). If the measures were highly correlated, the cloud should look like an ellipse aligned along the 45-degree line. This is clearly not the case here.

What to do with this degree of disagreement? Some argue that ESG ratings should

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KEY MESSAGES

- **The information that ESG raters produce is valuable**
- **Assessing ESG performance is conceptually challenging because we need to measure contextuality, additionality, and preferences**
- **ESG raters, specialized ESG data providers, and aggregators can harness economies of scale**
- **Regulators should enforce transparency of measurement and aggregation practices to increase competition between ESG raters to incentivize improvement**

be standardized, whereas others even go so far to say that the ratings should simply be disregarded. According to our research, both would be a mistake. Indeed, we find that ESG ratings do contain a signal. Furthermore, given the complexity of what ESG measurement entails, we believe that the only solution to gathering, analyzing, and aggregating the data runs through commercial ESG rating agencies and ESG data providers. We also do not believe that the standardization of ESG ratings would be an appropriate solution, as this would set in stone an imperfect measure, prone to be manipulated by firms and disincentivizing all research for further improvements. However, these future improvements are what ESG ratings clearly need.

IS THERE SIGNAL IN THE NOISE?

Given the disagreement, is there any signal at all in the ESG rating agency scores? The short answer is yes! Especially for the relationship between stock returns and ESG scores.

In our recent research (Berg, Kölbel and Rigobon 2022), we think of the score of a particular ESG rat-



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the total score. This also means that there clearly is a signal in the ESG ratings.

SHOULD WE MEASURE CO₂ ONLY?

Should we concentrate exclusively on CO₂ measures and disregard the rest? The short answer is no.

This recommendation implicitly assumes that the environmental dimension is better measured than the social or governance dimension. There are many reasons that suggest this assertion is incorrect. We discuss those below. However, even if it were the case that

CO₂ emissions are measured better than social aspects, such as discrimination of historically disadvantaged groups, the recommendation of measuring the first but not the second still does not make sense. Often the most relevant issues are hard to measure. Arguing that because something is difficult to measure it should be disregarded is questionable at best.

It is unwise to limit ourselves to only the things that are convenient to measure. Take the example of CO₂ emissions, whose components are measured with different degrees of precision. There are established accounting protocols and a clear unit with tons of CO₂ equivalents readily available to anyone interested in measuring CO₂. If firms provide the figure (usually voluntarily), we know a lot about a firm's emissions in the past. But we do not yet know the firm's future emissions, which are based on the decisions that the firm is making today. We also know very little about emissions in the firm's supply chain, usually referred to as scope 3 emissions.¹ Scope 3 emissions need to be estimated even by the firms who are disclosing them.

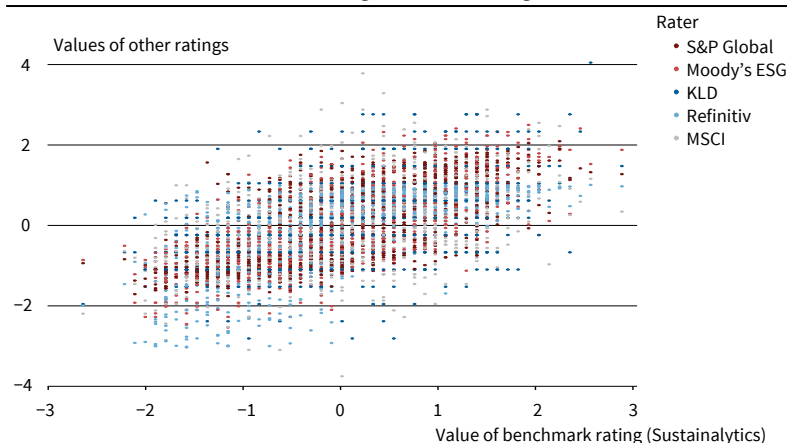
Furthermore, the reported CO₂ data needs to be put in context to truly understand a firm's impact on society. Let's have a little thought experiment to illustrate the concept of additionality regarding the CO₂ emissions of a firm. Assume there is a small town in Oregon that consumes 100 percent of the electricity from a small hydro plant producing 1 megawatt. Assume the plant is at capacity – meaning that it cannot produce a single additional kilowatt. Now, Amazon decides to put a massive AWS server nearby, and that the energy demand for the warehouse is also 1 megawatt. Amazon signs a contract with the hydro plant to purchase 100 percent of their electricity at a premium. The plant decides to sell to Amazon, and now the town is forced to buy electricity from the grid. The problem is that the electricity is from a coal plant, which clearly will produce CO₂ emissions. The question is, who is the one responsible for producing the CO₂? According to the expenses, Amazon is purchasing clean energy producing zero emissions and the town is buying the dirty energy. Hence, the Addi-

¹ See the EPA for the definitions: <https://www.epa.gov/climateleadership/scope-3-inventory-guidance>.

ing agency as the combination of some noise and an underlying true ESG performance. In our paper, we correct for the noise and find that the relationship between ESG scores and stock returns is positive and highly significant economically as well as statistically. Furthermore, we show that the reason why sometimes this relationship is hard to detect in the data, as has been the case in the literature, is precisely because the data is noisy. Think of a real-life situation, such as when you try to listen to a lecture with a lot of background noise due to construction work. The noise will drown out the signal and make the lecture harder to understand; however, the knowledge is still being imparted.

To disentangle the signal from the noise, we use an instrumental variable approach where we instrument the score of one rating agency with the scores of up to seven other rating agencies. This approach consists of two stages. First, we regress one ESG rating on the other ESG ratings. Here, we do indeed find that the rating agencies are measuring something that is common across them. Second, we regress the stock return on the predicted value from the first stage while controlling for a host of financial variables, industry, and time effects. By doing so, the coefficients more than double and become statistically significant. Our results suggest that the noise implied in the ESG measures is substantial with more than 60 percent of

Figure 1
Correlation Between Benchmark Rating and Other Ratings



Source: Berg, Kölbel and Rigobon (2022).

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tional impact of Amazon is 1MW of dirty energy. The actual economic accounting should assign 100 percent clean to the town, and 1MW dirty energy to Amazon regardless of the expenditure shares. However, in current accounting practices and in what Amazon would report to Carbon Disclosure Project, there would be zero emissions attached to this particular warehouse. Solving the problem of accounting for additionality has proven to be one of the most difficult tasks.

Is it easy to measure the treatment of female employees? Of course not! The share of women on the board is likely a very coarse indicator for discrimination. But we should still try to assess firms in terms of how they are handling such an important issue.

Understanding the limitations of the measurements is crucial. As we said, if something is important to society, it should be measured, but it also should be understood and recognized that the measurement is imperfect. This is particularly crucial for regulators to understand. For example, a complex problem such as discrimination and mistreatment of historically disadvantaged groups in the labor force cannot be summarized by simply looking at the proportion of these groups in management. If regulators focused on this statistic, firms might comply and achieve the right proportion of these groups in management but continue to mistreat them. In other words, firms might hit the target, but miss the point.

The point is, and should be, about treatment of historically disadvantaged groups regardless how many are in the organization. There is no possibility that the perfect measurement of the intentions can be achieved, so we need to learn to live with imperfect measurement – not only for discrimination but for almost all social aspects. This is a delicate balance that is difficult to navigate. On the one hand, if an issue is important, it should be measured – regardless how hard or uncertain the measurement is. On the other hand, what is done with the measurement is a matter of understanding its precision and accuracy.

As we showed above, the notion that CO₂ is properly measured, as suggested by many academics and practitioners, is problematic. In the last two decades, firms have been increasingly willing, to disclose their CO₂ emissions. The reported emissions have been collected by the Carbon Disclosure Project. Participation is voluntary, and the verification of that data is also voluntary. This implies that there are many missing observations. Many firms choose not to report and those that report are not necessarily representative of all firms. This is particularly pervasive in the carbon market. In total, 80 percent of the scope 1 and 2 CO₂ emissions provided by TruCost have been imputed, and about 95 percent of the scope 3 is imputed.² This procedure makes sense if we are interested in

obtaining an estimate of the “world” CO₂ emissions; but should these imputations be used for regulatory purposes? Is this truly a better measurement than the number of historically disadvantaged employees in management?

AGGREGATING DIFFERENT ISSUES

Should we standardize what ESG issues rating agencies should take into account and how important they are? The short answer is again no.

Let us assume that problems around the measurement of different issues, such as discrimination and climate change risks, have been resolved. The next question is if we can put these issues together in a single score – as is customary for the ESG rating industry. In other words, can we settle on one aggregation rule for an overall encompassing ESG rating? No chance!

Aggregation is fundamentally about preferences, and individuals have different preferences. Some people will think climate change is the most important issue, others feel more passionate about discrimination, others about biodiversity, and others about poverty. How can a single score capture the heterogeneity in preferences? Who are we to tell anyone what is important to them?

The standardization of ESG ratings entails the existence of what is known as a social welfare function. This is a function that, as its name indicates, captures what the preferences of society are. The social choice discipline in economics (and mathematics) has several interesting results regarding this function. First, when there are more than two issues, and preferences are heterogeneous, it is impossible to guarantee that the social welfare function exists. Unless it coincides with the preferences of a single person – which Arrow denominated the “benevolent dictator.” Indeed, in the 18th century, the Marquis de Condorcet proposed a paradox in which three rational individuals will behave irrationally when pairwise comparisons are made. Assume that there are three fruits: Apples, Bananas, and Coconuts. One agent prefers Apples to Bananas to Coconuts; the second one prefers Bananas to Coconuts to Apples; and the third one prefers Coconuts to Apples to Bananas. Each agent is individually rational and let us assume we name them members of our Congress to make the decision about which fruit we should serve. Humans tend to make pairwise comparisons (A versus B). Assume we vote, and each agent gets a vote. When comparing Apples to Bananas, Apple gets two votes (agents 1 and 3), and Banana one (agent 2). So, Apples are better than Bananas. When we compare Bananas to Coconuts, the first one gets two votes (agents 1 and 2) and Coconuts gets one vote (agent 3). So, Bananas are better than Coconuts. We would assume that if we were to compare Apples to Coconuts, it should be the case that Apples are better. However, that is not the case. Apples would

² Trucost is a product of S&P Global assessing risks relating to climate change, natural resource constraints, and broader environmental, social, and governance factors. It is widely used to measure CO₂ emissions.

get one vote (agent 1), and Coconuts would get two votes (agents 2 and 3). Hence, even though we can represent the preferences of each individual, we often cannot represent the preferences of the aggregate.

Some argue that the default objective should be financial materiality and the maximization of stock returns. This might indeed define an aggregate index and it might make sense when you sell your data to investors, but it is a poor social welfare function when thinking about resolving the underlying issue (Simpson, Rathi and Kishan 2021). For example, assume that child labor is not materially important in a sector. Should we not measure it? Should we measure it and not include it in the index? This is a very difficult problem to solve, especially because almost no one has asked investors and consumers about their preferences. Therefore, not surprisingly, the rating agencies are proposing different aggregation rules – which generates another source of discrepancy.

In addition, ESG rating agencies currently use quasi-linear aggregation rules. Our research shows that this implies certain trade-offs that would make most people feel very uncomfortable. Again, a simple example makes the point. Assume that you measure discrimination against two different groups, women and LGBTQ+. The aggregate score of each firm is determined by the average between the scores for women and for LGBTQ+ (the example holds for any linear weighted average technique). Imagine that one firm gets a score of 60 for discrimination of women and 20 for people identifying as LGBTQ+, the aggregate score being 40. Imagine the firm feels bad because they think they are discriminating LGBTQ+ too much (score of 20), and they come to the rating agency and ask: “I want to keep my overall score constant, is it okay if I discriminate woman more and a little bit less LGBTQ+ such that the aggregate remains at 40?”

Most would say that the question is unacceptable, and that the individual should improve the treatment of women without deteriorating the treatment of any other group. In fact, treating one individual correctly is not a license to treat another one badly. This notion, however, is not captured by a linear aggregation rule, but by a non-linear one. Our research shows that the ESG scores can indeed be approximated quite precisely with a linear aggregation rule. This means that firms can make decisions that imply trade-offs that could be unacceptable to most citizens. Therefore, it is possible to compute how many tons of CO₂ a company can emit more if it adds one more woman to the board - keeping the overall score constant

Some people are actually willing to trade-off between certain issues but most likely not in a linear way. For instance, some could be willing to accept a small deterioration of the human rights record of a firm if this is accompanied by a massive reduction in CO₂ emissions. But this calls for more research on preferences and aggregation functions. Hence, a

standardization of ESG ratings would also disincentivize improvements about how to build the optimal aggregation function for a given investor.

CONCLUSIONS AND POLICY IMPLICATIONS

Would the world be a better place without ESG ratings? Our research implies no. The information that ESG raters produce is valuable. And assessing ESG performance is not only conceptually challenging, but also labor intensive. ESG rating agencies need to assess many issues: CO₂ emissions, water, biodiversity, labor treatment, discrimination, inclusion, product safety, marketing practices, supply chain, lobbying, corruption, and taxes, among others. They need to make this assessment for thousands of companies and update it regularly. If you find this task daunting, you are in good company. Of course, it is costly to undertake, but it is worth doing, because ESG issues matter. Rating agencies can harness economies of scale, and competition among them helps to drive down costs, if the market is set up the right way.

What would be a good market setup for ESG ratings? The key is to create a competitive market, where competition is centered around the quality of measurement. We believe there are three useful steps regulators should take: standardize ESG disclosure (not the ratings), enhance transparency about methodologies, and encourage compatibility between rating systems.

When it comes to standardization, regulators need to distinguish between firm disclosure of ESG data and ESG rating agencies themselves. Firms often rely on disclosure frameworks such as the Global Reporting Initiative, the Sustainability Accounting Standards Board, and the Greenhouse Gas Protocol to publish ESG-related data. For instance, if firms count CO₂ emissions differently, it would be hard to interpret that data. Hence, standardization with the help of disclosure frameworks is useful. ESG rating agencies can then use this data, check if it is credible, add data from third-party sources, and thus form an opinion about the ESG practices of the underlying firm. If valid and standardized ESG data is widely available, ESG ratings can compete more on interpreting the data, and less on collecting the data privately. There will still be divergence, but it will be divergence in opinion, not disagreement about facts.

With regard to ESG ratings, we believe standardization of how and what ESG ratings measure, with the aim of making them diverge less, would ultimately result in less reliable information. However, regulators should increase transparency about measurement practices and aggregation rules. Indeed, without transparency, there cannot be any competition between the best measurement practices or aggregation rules.

Finally, regulators (but perhaps also market participants themselves) should develop a taxonomy for how the issues within E, S, and G are broken down.

There are many reasonable ways to slice and dice ESG issues, but the fact that each rater does it differently makes comparison across raters unnecessarily difficult. This is a compatibility problem, similar to the problem of when you switch your cellphone, you cannot use your old charger anymore, which provides exactly the same function, just with a different plug. From the perspective of the users of the ESG ratings, it is far more convenient if the sub-scores are available in the same set of categories. This makes it easier to compare and switch to alternative providers, which fosters competition.

In sum, can the data and procedures be improved? Yes. Can the discrepancy be made smaller? Of course. But does that mean that the data today is useless, that it should not be used as a measuring stick, or that some of it needs to be standardized or even disregarded? No. ESG ratings are useful and relevant today, and it is essential to maintain investment and innovation in ESG ratings. The existing shortcomings are not a reason to resign. Instead, they call for redesign.

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Emanuela Benincasa, Gazi Kabas and Steven Ongena

Uncoordinated Climate Policies: Implications for Cross-Border Lending

KEY MESSAGES

- **There are substantial differences across countries regarding climate policy stringency**
- **Banks react to a stricter climate policy at home by increasing their cross-border lending to countries with laxer climate policies**
- **The evidence is consistent with the adverse effect of transitional climate risks on firms, possibly reducing banks' domestic loan portfolio performance**
- **Global coordination in climate policies is needed to prevent race-to-the-bottom behavior**

The dire effects of climate change call for urgent and effective measures, posing challenges for financial markets and the economy. Many policy institutions across the world have recognized the global nature of these challenges and have been discussing how to update their mandates accordingly. For example, President Biden recently issued an “Executive Order on Tackling the Climate Crisis at Home and Abroad” where he stressed that “domestic action must go hand in hand with United States international leadership, aimed at significantly enhancing global action.”¹ Even though climate change entails global coordination and cooperation, there are still significant differences across countries regarding climate policy stringency.² This difference can make the fight against

¹ For more details, see <https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad/>.

² For instance, Germany has introduced financial aid to support research on technologies for decarbonizing heavy industry. In contrast, the U.S. Senate did not pass the Build Back Better Act due to the provisions it would have introduced related to climate change.

climate change more difficult if it starts a “race to the bottom” (Benincasa, Kabas and Ongena 2022).

A stricter climate policy may have two possible yet diverging implications in the domestic lending market: On the one hand, it may increase firms’ demand for funds for innovation and green technologies. Since banks are the primary funding source for firms, stricter climate policy can increase demand for bank lending. To the extent that banks meet this demand, stricter climate policy can increase domestic lending. Due to limited lending capacity, banks may balance the increase in domestic lending by decreasing their cross-border lending. On the other hand, banks may consider a stricter climate policy a threat to their domestic loan portfolios. This can happen, for example, if the needed innovation and green technologies lower firm profitability. Lower profitability, in turn, may adversely affect loan portfolios, discouraging banks from domestic lending. Under this scenario, banks may increase their cross-border lending, especially to countries with laxer climate policies. These two opposing mechanisms make the effect of domestic climate policy stringency on cross-border lending an empirical question.

In this article, we study this question and contribute to the understanding of the link between domestic climate policy stringency and cross-border bank lending. Specifically, we investigate whether banks use cross-border lending to react to a change in climate policy stringency in their home country. To this aim, we leverage two main data sources: syndicated loans in the period 2007–2017 and a global measure for climate policy, the Climate Change Performance Index (CCPI). Results suggest that banks react to stricter climate policy in their home country by increasing their cross-border lending. To better understand the size of this effect, consider a hypothetical example of a cross-border syndicated loan where one lender is located in Germany, the other lender is in the U.S., and the borrower is in a third country, say, Poland. Our results indicate that Germany’s six index points stricter climate policy in 2015 led the bank in Germany to have a 6 percent higher loan share in this loan compared to the bank in the United States. We show that banks shift their cross-border lending to countries with laxer climate policies, which indicates that this effect is driven by banks’ aim to protect their loan portfolio from the risks entailed by stricter domestic climate policy.



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A MEASURE FOR CLIMATE POLICY STRINGENCY

We measure climate policy stringency using the Climate Change Performance Index (CCPI). The CCPI is an index constructed by Germanwatch, a non-governmental environmental and development organization. Germanwatch updates the index annually with the purpose of enhancing transparency in countries' climate protection action (Burck et al. 2016).³ The index, which is published annually, covers 57 countries outside and within the European Union and takes values between 0 and 100, where a higher value corresponds to a stricter climate policy. The index is constructed by using fifteen measures with four main categories. These categories are Greenhouse Gas (GHG) Emissions (60 percent), Renewable Energy (10 percent), Energy Efficiency (10 percent), and Climate Policy (20 percent). GHG Emission considers countries' emission levels, and Renewable Energy assesses the share of renewable energies used by a country to achieve an effective emission reduction. Energy Efficiency measures the reduction of energy use needed for products and services. The Climate Policy category is based on assessments made by 300 experts and non-governmental organizations, and it considers the measures taken by national governments to reduce greenhouse gases. Importantly, the category results from a research study conducted by researchers and organizations that are not (in any way) connected to their national governments. This aspect of independence makes this category unique.

Assessing climate policy strictness with an index has two main advantages. First, an index is a transparent measure which is independent of researchers' subjective choices. Second, an index makes global comparison in countries' climate policy possible and easy, as there are different policies across countries.

Figure 1 shows the average CCPI for each country in our sample. The map plots the average climate policy strictness in shaded colors, where darker colors proxy a strict climate policy country. We can see that the climate policy strictness varies across countries with European countries having a stricter climate policy compared to emerging economies, and Anglo-Saxon and Asian countries. As expected, Scandinavian countries outperform in their climate performance, on average.

SYNDICATED LOANS TO STUDY CROSS-BORDER LENDING

To measure cross-border lending we use syndicated loans from LPC DealScan database. LPC DealScan provides comprehensive loan-deal information on a global level. We restrict the analysis to the sample of

³ Germanwatch publishes the index in collaboration with the New Climate Institute and the Climate Action Network. The index is available starting from 2005 onwards.

loans originated between 2007 and 2017 due to availability of the climate policy data.⁴

Our sample comprises a total of 399 banks of which 276 are parent banks located in 32 countries. We hand-match the loan-level data with bank balance sheet data from Bureau van Dyck Bankscope. Importantly, we leverage this hand-match exercise to gather information on the location of our sample banks, for which we use the country where they are located. The dependent variable of our analysis is lender share, which is the share of a lender in a cross-border syndicated loan. We define a loan as cross-border on a locational basis, whereby the lender and borrower are located in different countries (De Haas and Van Horen 2013). Our cleaned and final estimation sample comprises 27,086 loan shares, of which 12,478 are cross-border. The average value of cross-border loan shares is 7.72 percent with a standard deviation of 7.98.

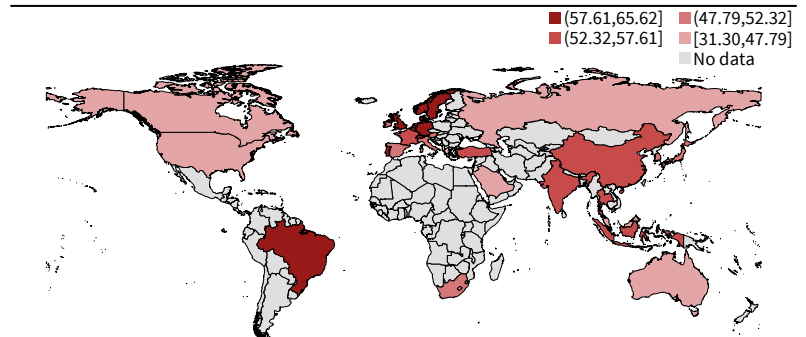
⁴ Our study focuses on loans to non-financial firms by commercial, savings, cooperative, and investment banks. In addition, we follow Doerr and Schaz (2021) and consider as a bank all lenders defined in DealScan as Commercial Banks, Finance Companies, Investment banks, Mortgage Banks, Thrift/S&L, and Trust Companies.



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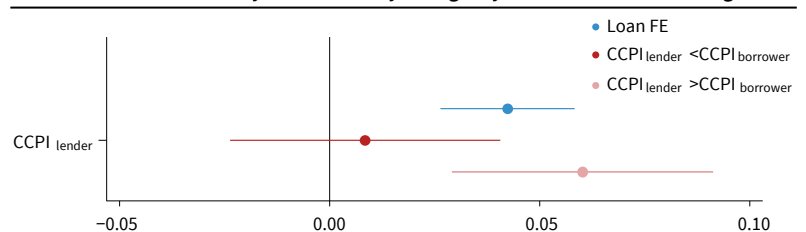
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Figure 1
Average Home Country Climate Policy



Note: This map reports the average Climate Change Performance Index (CCPI) score per each country included in our sample over sample period 2007–2017. The shade in color proxies the average value – darker areas indicate higher average values (more stringent climate policy). Countries with no color shade are not part of our sample. Source: Germanwatch (2020). © ifo Institute

Figure 2
The Effect of Home-country Climate Policy Stringency on Cross-border Lending



Note: This graph reports regressions coefficients (betas) from baseline specification. The dependent variable is Lender share and the main independent variable is CCPI (lender). The sample covers the period 2007–2017. All regressions include bank group level controls (net interest margin, Tier 1 capital ratio, log(total assets), log(customer deposits), and liquidity ratio). The blue line reports the coefficient estimate for this baseline regression when we include loan fixed effects. The green and red line reports the coefficient estimate when we saturate the model with loan fixed effects and split the sample in CCPI index of the lender's country higher/lower (above/below median sample) than the one of the borrowers' country. Standard errors are clustered at the lender's country-year level and shown in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Source: Authors' calculations (2022). © ifo Institute

BANKS LOCATED IN COUNTRIES WITH STRICT CLIMATE POLICY INCREASE THEIR CROSS-BORDER CREDIT SUPPLY ABROAD TO LESS STRINGENT CLIMATE POLICY COUNTRIES

In this section, we discuss the main results when we study the effect of home-country climate policy on cross-border lending controlling for loan demand via saturation with loan fixed effects. Therefore, we compare lenders' shares in the same loan holding fixed borrowers and loan characteristics.

Figure 2 plots the estimated coefficients from our regression model. Specifically, we run a regression where the dependent variable is Lender share and the main independent variable of interest is CCPI (lender). Our regression is saturated with relevant bank-level controls and with a loan fixed effect to absorb credit demand drivers. In blue, we report the main estimated coefficient which suggest that banks react to higher climate policy strictness in their home country by increasing their cross-border lending: A one standard deviation higher climate policy strictness results in an average increase in the cross-border loan share of approximately almost one percentage point (pp), corresponding to a nine percent increase relative to the mean loan share (7.72 percent).

So far, our results show that a stricter climate policy leads to an increase in cross-border lending. We are left with the understanding of whether banks increase their cross-border credit supply abroad to countries with laxer climate policy. Research shows that when banks face stricter regulation in their home country, they shift their activities from their home country to countries with looser regulation (Karolyi and Taboada 2015; Houston, Lin and Ma 2012; Ongena, Popov and Udell 2013). We analyze this by splitting the sample into two in terms of the difference between CCPI of the lender and CCPI of the borrower. We find that CCPI of the lender has a positive and statistically significant coefficient (in green) when CCPI of the lender is higher than CCPI of the borrower. In contrast, it has an economically and statistically insignificant coefficient (in red) when CCPI of the lender is lower than CCPI of the borrower, which provides additional support to our conjecture.

POLICY CONCLUSION

Both policymakers and academicians discuss climate change and policies to prevent it. Even though there is little doubt about the importance of the topic, large differences about the policies on climate change and their intensity exists. These differences can create ways for stakeholders to circumvent climate policies that would impact them negatively. In Benincasa et

al. 2022, we consider a specific stakeholder, banks, and investigate how banks adjust their cross-border lending as a reaction to stricter climate policies in their home country. Our work documents that banks increase their cross-border lending significantly after their home country increases the climate policy strictness. This finding is mainly driven by a race-to-the-bottom behavior since the increase in cross-border lending does not occur if the borrower's country has a stricter climate policy. In line with a race-to-the-bottom behavior, we also observe that as borrower countries adopt stricter climate policies, the incentive for banks to extend cross-border loans decreases.

Our work indicates one crucial missing element in the current climate policy framework. Due to a lack of global coordination among the countries, ways for banks to find loopholes within a fractured global policy network and avoid stricter climate rules exist. By increasing their cross-border lending to countries with laxer climate policies, the banks may ultimately reduce the effectiveness of these policies. Therefore, global coordination is needed to prevent such actions from happening.

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Asset Overhang and the Green Transition*

INTRODUCTION

Policymakers worldwide have an important role to play in designing an adequate climate-finance framework (Borio, Claessens and Tarashev 2022; De Haas and Popov 2022; Giglio, Kelly and Stroebel 2021). In a recent report requested by the Presidency of the Climate Change Conference (COP27), the Independent High-Level Expert Group on Climate Finance stresses that transforming our economies to mitigate the ongoing climate crisis “[...] requires strong investment and innovation, and the right scale of finance of the right kind and at the right time” (Songwe, Stern and Bhattacharya 2022). In particular, the authors argue that “while there is broad private sector commitment to align with climate, there is now a need to develop approaches that can unlock institutional capital at scale. Asset owners and other stakeholders need to be incentivized to come up with more solutions.”

In this article, however, we introduce one possible mechanism that may actually be preventing a rapid financing at scale of environmental technologies by the private sector. We provide empirical evidence for the case of bank loans to green projects. We further discuss how limited policy interventions would play an active part in reducing or eliminating such barriers by achieving an overall alignment of incentives between market participants and stakeholders.

An “asset overhang” arises when an investment related to a disruptive technology threatens the legacy investments of an external financier (Degryse, Roukny and Tielens 2022). The following scenario illustrates our theory: Assume a bank with a long-standing portfolio of investments in carbon-intensive industries. This bank now receives a request for a large loan by a firm seeking to implement a carbon-light

* The views expressed in this contribution are those of the authors and do not necessarily reflect the views of the National Bank of Belgium, the Eurosystem, or any other institutions to which the authors are affiliated. This contribution draws on earlier work of Degryse, Roukny and Tielens (2022).

KEY MESSAGES

- **Environmental technologies threaten dirty legacy portfolios of external financiers**
- **“Asset overhang” refers to an investor’s incentive not to finance disruptive green firms in an attempt to protect exposed legacy positions**
- **Empirically, asset overhang renders green disruptors up to 4.4 percentage points less likely to receive external finance**
- **The presence of financiers with low asset overhang trigger systemwide incentives to fund green firms**
- **Limited policy interventions aimed at reducing such overhang can alleviate financial barriers to the green transition**

business model using environmentally friendly technologies. One concern that may exist on the bank’s side would be whether the commercial success of this green firm might result in a devaluation of some former investments: either because the green firm would steal away business from incumbent clients, or because the superior technology brought by the green firm would devalue some of the collateral posted by incumbents. As a result, the bank may demand compensation for these expected losses, eventually rationing the green firm. The existence of negative green spillovers therefore imposes an overhang on the bank, which in turn reduces its incentives to fund the green firm’s profitable project.

Faced with this barrier, the green firm may simply decide to move to other banks in the economy and hope they do not face an asset overhang. To determine the extent of the aggregate funding supply fric-



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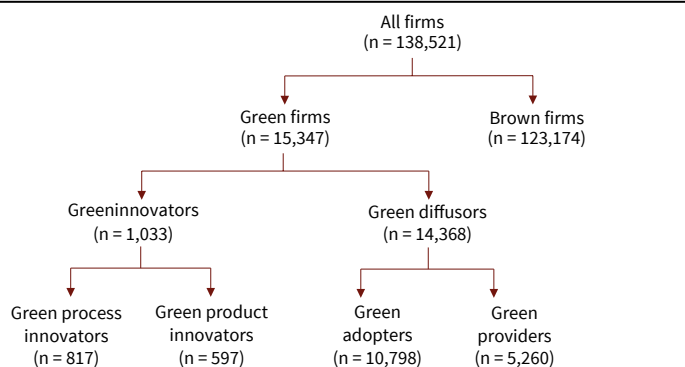
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Figure 1
Incidence of Various Green Activities by Belgian Firms



Source: Degryse, Roukny and Tielens (2022).

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tion to the new disruptive technology, we therefore need to analyze the market structure of the banking system’s asset overhang. In systems where all banks have a large legacy portfolio exposed to the disruptive technology, all banks have incentives not to support this technology’s development or widespread uptake. Why? The strategy of deliberately not investing in a (standalone profitable) technology averts the adverse spillovers on their legacy investments. That is, the decision to not invest prevents their legacy investments to become stranded assets. However, the presence of investors with limited or no exposures to the negative impact triggers credit supply by the entire system (including from financiers heavily impacted by the new technology), as negative externalities on legacy investments, such as devaluations of pledged collateral or elevated default risk of incumbent borrowers, cannot be prevented in that case.

An asset overhang friction in the financing of disruptive technologies may generalize beyond green technologies to multiple settings where the entire pool of investors is exposed to large enough technological disruption. However, the case of climate change and the financing of green technological transitions by banks is particularly relevant. First, there is ample evidence that banks are highly exposed to assets and industries subject to strong disruptions due to climate change (ECB 2019). Second, a large share of economies worldwide continue to rely on bank financing, in particular in developing economies. Developing economies have recently become a main focus on climate finance due to their limited market capacities: Songwe, Stern, and Bhattacharya (2022) estimate that “The world needs a breakthrough and a new roadmap on climate finance that can mobilize the \$1 trillion in external finance that will be needed by 2030 for emerging markets and developing countries.” Third, while alternative financing opportunities may exist for technological innovation, the process of technological diffusion – which is equally important when it comes to achieving technological change – is largely supported by bank-financed firms even in economies with developed capital markets. For instance, the recent energy package passed by the U.S.

Senate under the Inflation Reduction Act includes \$27 billion of funding directed to green banking in order to support the adoption of greenhouse gas reduction technologies in parts of the economy underserved by the private sector. Finally, note that even in countries with credible alternative financing sources, such as in Europe, innovation in green technology has been underperforming (Aghion et al. 2022). Below, we provide evidence of an asset overhang mechanism at play in reducing the development and dissemination of green technologies.

EMPIRICAL APPLICATION

Our empirical application studies whether green technologies suffer from an asset overhang problem in the market for corporate bank credit, leveraging data from a heavily bank-based economy (Belgium).

Our application first pins down the externalities to which firms are exposed to when other firms unfold their environmental activities. The linchpin of our identification strategy has two main features: First, in the spirit of Hall and Helmers (2013), we take a two-tiered view on environmental activities. Green activities either take the form of green innovations (i.e., development of new environmentally friendly products and production processes) or green diffusion (i.e., adoption or selling of environmental products and services that embody an incumbent green technology). Drawing on various unique large-scale datasets, we directly observe both components of technological change at the firm level (Figure 1). This bifurcated view is warranted as the two activities differ in their financing and disruptive capacity (Utterback, 1974) – and therefore might trigger different levels of overhang problems – while both are instrumental in the net-zero transition (Aghion, Veugelers and Serre 2009). Second, following Bloom, Schankerman, and Van Reenen (2013), we empirically distinguish each firm’s position in the technology space and product market using granular information on the distribution of firms’ input and output markets (inferred from detailed B2B transactions). This allows us to construct distinct measures of economic distance between “firms with environmental activities” and “other (dirty) firms” in the technology (input) and product (output) market dimensions. We leverage both ingredients to trace out adverse spillovers of green activities on neighboring dirty firms.

We focus on two types of externalities that were previously documented to weigh heavily on banks’ lending decisions: firm performance (as proxied by firm household sales, corporate sales, market shares, etc.) and pledgeable asset values (measured by losses incurred on secondary markets upon liquidation of tangible assets, etc.). The former are taken from granular VAT declarations. The latter are taken from a widespread business survey. We apply this framework to a panel of Belgian firms over the period 2008–

2018 and document that firms with green innovation and/or green diffusion generate negative spillovers on brown firms through deteriorated firm performance and asset devaluations.

We provide further corroborating evidence that these induced firm-level externalities stemming from green technology effectively feed into the banks' assessments of their incumbent borrowers. First, we find that green innovation and diffusion is associated with elevated probabilities of default and additional provisioning reported by banks on their incumbent dirty borrowers. Second, we observe adjustments in market values of firms' pledged collateral in the face of (particular types of) environmental innovation & adoption by technology peers.

Armed with the established externalities, the second step in our analysis proceeds to quantify the share of individual bank's legacy positions threatened by each individual firm's green activities using bank-firm credit exposures as reported in the corporate credit registry. This allows us to study the impact of the magnitude and structure of the banks' legacy portfolio at risk on credit allocation to environmental firms. A priori, banks are expected to take on board these exposures in their lending decisions as Figure 2 reveals a significant amount of the corporate credit portfolio at risk to the population of innovators and diffusers of environmental technology.

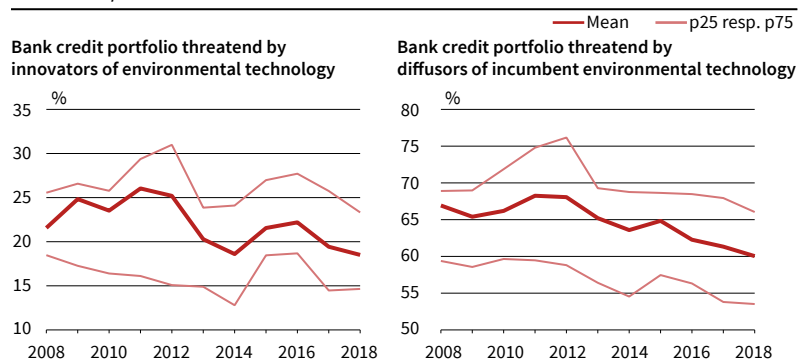
EMPIRICAL FINDINGS

We estimate that,

1. Being a large threat to the legacy portfolios of all banks (i.e. a one standard deviation negative impact on each bank in the credit market) makes a green innovator (diffuser) around 4.4 p.p. (1.0 p.p.) less likely to receive bank credit compared to an otherwise equal innovator (diffuser) that does not have an impact on banks' legacy positions.
2. The rationing effect is largely muted by the presence of intermediaries with low asset overhang.
3. We further study, conditional on lending, which bank in the asset overhang spectrum matches up with the green firm. We find that the bank with the smallest asset overhang is 8.4 p.p. more likely to grant a loan to the green firm relative to any other bank in the system. That is, investors with less asset overhang are more likely to "break the barrier" to technological disruptions.
4. In the context of an existing relationship between a bank and firm, we document that changes in the asset overhang of the incumbent lender do not play a role in credit supply to the environmental firm. Instead, a 1 s.d. decrease in the lowest asset overhang position (potentially, but not necessarily, that of the incumbent lender) drives up credit supply by the incumbent lender to the disruptive innovator (diffuser) by 0.11 s.d. (0.05 s.d.).

Figure 2

Share of Banks' Corporate Credit Portfolio Negatively Exposed to Environmental Innovators/Diffusers



Source: Degryse, Roukny and Tielens (2022).

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Taken together, these results highlight that the distribution of asset overhang across investors determine credit supply to disruptive firms both at the extensive margin (i.e., whether a firm receives any credit from a bank) and – once the rationing barrier is broken – at the intensive margin (i.e., how much credit is received by the firm in the context of an existing relationship with a bank).

POLICY IMPLICATIONS

Our framework suggests that economies may suffer from technological conservatism when new technologies threaten the legacy position of investors through changes in performance and asset devaluation. Empirical evidence from the Belgian economy reveals that bank lending policies effectively aim to protect business models that do not fit into global commitments to transition into a green economy. Various policy measures can help to breach the source of this barrier at the investor level.

The first measure could be promoting financial institutions that do not hold legacy positions exposed to the negative spillovers originating from disruptive technologies. This outcome can be achieved by several initiatives.

First, it can be by design: promoting financial institutions with explicit intentions of supporting the production and diffusion of specific green technologies. This case commands particular business models and expertise to be sustainable. Large-scale demand such as the fight against climate change can promote such conditions. Relevant examples include the UK Green Investment Bank, or the Green Credit department of ICBC China. Moreover, to the extent that these initiatives are public (or quasi-public), their mandate potentially does not require them to factor in the impact of the disruption (i.e., their behavior is not governed by our framework) should these externalities appear later on in the financiers' life cycle. In a more general setting, where the demand and need for technology transitions are not specifically formulated upfront, a generic policy of promoting entry of

new – hence legacy-free – financial institutions would achieve a similar result from the perspective of our theoretical and empirical analysis.

Perhaps more important to note is that the presence of at least one legacy-free financier has the capacity to produce larger scale effects: the presence of investors with less or no exposures to asset devaluations promotes credit provisioning by the entire system. By virtue of this result, the entry of a single sizeable investor with no legacy exposures would effectively mute overhang issues and break rationing barriers. In other words, the existence of spillovers may positively amplify the effectiveness of limited interventions (i.e., entry of a single legacy-free agent). In fact, the devaluation of legacy assets materializes irrespective of the loan originator. Therefore, once the entry of a disruptive technology is certain, losses will materialize irrespective of the loan originator. Accordingly, all investors in the system become theoretically likely to extend credit to disruptive technologies. This is confirmed in our empirical analysis where a reduction in the lowest asset overhang engages incumbent banks to increase credit supply at the intensive margin.

Focusing on incumbent institutions, policymakers have voiced the possibility of leveraging macro prudential policies to address the green transition (European Central Bank 2019; European Union 2018). Such policies work by introducing an additional implicit/explicit cost which either (i) increases if the investor (e.g., bank) persists in lending to laggard firms, or (ii) drops when it lends to innovative firms. The investor's behavior can then be steered by driving the sign of the difference between this cost and the cost of technological disruption on the legacy assets. In the case of climate change, banks would therefore prefer to lend to green firms if this difference is negative. Examples include (i) a risk-weight reduction (addition) in the prudential framework for banks' exposures to green (brown) assets, (ii) lower (higher) required reserve rates for portfolios skewed toward greener, less carbon-intensive assets (brown, carbon-intensive assets), (iii) dedicated disclosure requirements, and (iv) climate-related stress testing, etc. Evidently, the feasibility of such measures hinges on a proper taxonomy (a classification of economic activities and

the conditions under which economic activities can be considered sustainable) to sort between green and brown firms. Such work is underway at the European Commission.

Our theory suggests that an asset overhang materializes when new technologies have a large potential for adverse spillovers to which the full pool of eligible investors is exposed. While the climate-banking application satisfies these criteria, there are other applications which meet similar conditions, thereby warranting an overhang analysis as well. For instance, the pool of candidate investors in advanced niche technologies (e.g., AI, cloud computing, biotech etc.) is typically restricted due to the intimate knowledge required to screen candidate projects. This screening ability is typically acquired through experience in funding projects embodying similar or adjacent technologies which may potentially suffer from the entry of disruptive rivaling projects. If the latter legacy projects still feature on the investors' balance sheet, they have incentives to ringfence their legacy from competing novel technologies.

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Benjamin W. Arold

Do School Curricula Matter to Students in the Long Run?

The Case of Teaching the Theory of Evolution or Creationism in the United States*

Since Charles Darwin's publication of "On the Origin of Species" in 1859, US policy-makers have engaged in heated debates as to whether evolution theory should be taught in public schools. At the beginning of the 20th century, teachers covering evolution in US schools faced strong opposition (Beale 1941). Some states, such as Tennessee, banned the coverage of evolution in public schools entirely. A famous example of this was the Scopes trial of 1925, in which John T. Scopes, a biology teacher from Tennessee, was convicted under the Butler Act for teaching evolution in the classroom (Numbers 1982). Throughout the second half of the 20th century, legislative decisions gradually paved the way towards more evolution teaching. In 1967, the Butler Act was revoked by Tennessee's state legislators. Although this and further decisions gradually allowed for a more comprehensive teaching of evolution, even today there is substantial variation in the way that evolution is covered in education standards, both across US states and within states over time.

But does the teaching of evolution actually make any difference to students? About 65 percent of the US population agree that humans have evolved over time (Pew Research Center 2015). While the literature has identified such factors as parents (Bisin and Verdier 2001; Guiso et al. 2008; Tabellini 2008) and social networks (Sacerdote 2001; Bailey et al. 2020) as determinants of attitudes, I ask whether schools play a role in shaping scientific attitudes. More specifically, does the coverage of evolution in US education go on to affect students' attitudes towards evolution in adulthood? And what role does it play in students' high stakes life choices?

In a new paper (Arold 2022), I show that evolution teaching has lasting effects on students. Greater exposure to evolution teaching not only improves students' knowledge of evolution by the time they graduate from high school, but it also enhances their belief in evolution in adulthood. What is more, the reforms affect high-stakes life decisions, namely the probability of choosing a career in life sciences.

* This article is based on the column "The Teaching of Evolution Theory Shapes Students' Beliefs and Choices" published on VoxEU.org, <https://cepr.org/voxeu/columns/teaching-evolution-theory-shapes-students-beliefs-and-choices>, 20 Oct 2022.

KEY MESSAGES

- **The teaching of evolution theory in school has a lasting impact on students**
- **Reforms of the coverage of evolution in US education standards have a positive effect on students' knowledge of evolution by the end of high school**
- **These reforms translate into a greater belief in evolution in adulthood, without crowding out religiosity or affecting political attitudes**
- **They also affect high-stakes life decisions, such as the probability of choosing a career in life sciences**
- **These findings imply that science education is an effective tool for fostering scientific attitudes and tackling the shortage of STEM workers**

US REFORMS OF EVOLUTION TEACHING

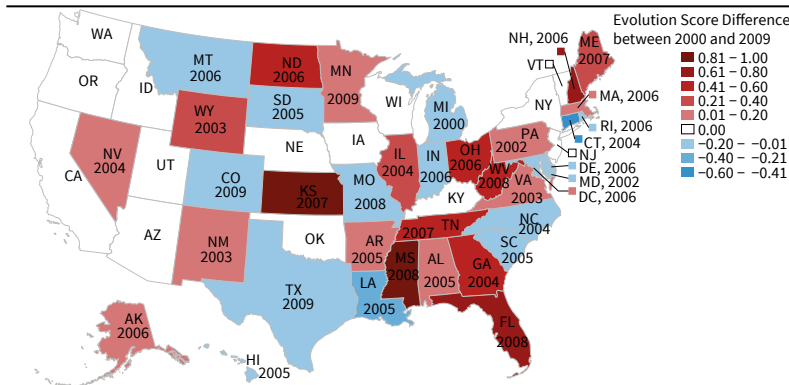
Estimating the causal effects of school curricula is generally challenging, as they are not randomly attributed to students but largely reflect the population's attitudes and beliefs. Therefore, simply matching students' exposure to evolution teaching with their belief in evolution once they reach adulthood will likely not yield the causal effect of interest. To isolate the causal effect of evolution teaching, I exploit staggered state-level reforms of evolution-related content in the US State Science Education Standards. The predetermined timing of gubernatorial elections, in combination with the tenure of members of State Boards of Education, creates idiosyncrasies in the determination of the exact years of a reform. Furthermore, my two-way fixed effects approach explicitly accounts for a wide range of endogeneity concerns, by com-



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Figure 1
US Map Showing Differences in Evolution Scores between 2000 and 2009



Note: The map depicts the evolution score difference, which is defined as the evolution score for 2009 minus the evolution score for 2000. A positive (negative) difference implies an increase (decrease) in the score between 2000 and 2009, as indicated by the blue (orange) coloring. White coloring indicates that there was no change in an evolution score between 2000 and 2009. The years reported below the two-letter state codes are the years of the respective reform.
Source: Arold (2022), Lerner (2000), Mead and Mates (2009).

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paring adjacent cohorts around sharp reforms in education standards.

To conduct my analyses, I link state-level data on the coverage of evolution in Science Standards with three individual-level datasets. Evolution coverage is measured by the so-called “evolution score”, constructed by Lerner (2000) and Mead and Mates (2009). The scores range from 0 to 1, with a higher score indicating a more comprehensive coverage of evolution. Over the study period of 2000 to 2009, 22 states increased the coverage of evolution in their education standards, while 15 states reduced it (Figure 1).

REFORMS AFFECT EVOLUTION KNOWLEDGE IN SCHOOL

To test whether the evolution coverage in the Science Standards affects what students learn about evolution in school, I use data from the National Assessment for Educational Progress (NAEP). This is a standardized student achievement test that assesses US students’ knowledge of a variety of subjects and issues. The NAEP test for science in grade 12 contains questions on evolution. I link the share of questions on evolution answered correctly by a given student to the evolution score that was in force in the state and year of his or her high school entry.

I find that students exposed to more comprehensive evolution coverage in high school are more likely to be able to correctly answer questions on evolution by the end of high school, conditional on the fixed effects of state and year as well as individual-level controls. More specifically, a change in evolution score from 0 to 1 increases the share of evolution questions answered correctly by 5.8 percentage points (18 percent of the sample mean). Given that scientific knowledge positively impacts earnings and economic growth (Lucas 1988; Barro 2001; Hanushek and Woessmann 2008, 2012), this finding is of direct economic significance.

In summary: The more students are taught about evolution in high school, the more they know about evolution. Two additional findings from this analysis strengthen its causal claim: First, an increase in evolution coverage is not linked to students’ non-evolution-related scientific knowledge, which can be interpreted as a placebo test to detect general scientific confounders. Second, the reforms have no effect on private school students’ knowledge of evolution, for whom the Science Standards have never been binding.

EFFECTS TRANSLATE INTO BELIEF IN EVOLUTION IN ADULTHOOD

I also examine whether the reforms evaluated have any lasting effect on evolution beliefs in adulthood. I use data from the General Social Survey, which asked a representative sample of US adults about their belief in evolution. This elicited a wide range of further scientific, religious, and political attitudes. As the data also records the respondents’ year of birth and state of residence at the age of 16, I can approximate the year and state of high school entry and merge it with the corresponding evolution score.

I find that students’ exposure to evolution teaching in school affects the probability of their believing in the concept of evolution in adulthood. Compared with no coverage at all, extensive coverage of evolution increases the probability that a student will believe in evolution in adulthood by 33.3 percentage points (57 percent of sample mean).

In contrast, I find that evolution coverage has no effect on non-evolution-related scientific, religious, and political attitudes, lending empirical support to the interpretation that a reform’s timing is not affected by scientific, religious, or political shocks. This finding complements studies of the effects of school curricula on economic and political attitudes in China (Cantoni et al. 2014) as well as on religious attitudes in Germany (Arold et al. 2022).

REFORMS ALSO AFFECT HIGH-STAKES OCCUPATIONAL CHOICES

Finally, I analyze whether the evaluated reforms of teaching evolution theory affect high-stakes choices, in particular career choices. I hypothesize that learning about evolution, the fundamental theory of life sciences, increases the probability that a student will choose to work in life sciences in adulthood. To measure how evolution teaching impacts occupational choice, I use data from the IPUMS American Community Survey (Ruggles et al. 2020), which contains detailed information on respondents’ fields of occupation as well as their state and year of birth.

I demonstrate that compared to having had no evolution coverage at all, exposure to comprehensive evolution coverage increases the probability of a student working in life sciences in adulthood by 23

percent of the sample mean. This effect comes predominantly from the subfield of biology, the subject in which evolution is typically taught. Supporting the empirical strategy, evolution teaching does not affect the probability of a student working in a non-scientific occupational field.

POLICY IMPLICATIONS

More generally, this study suggests that science education can be used to foster scientific knowledge and beliefs and to attract future STEM workers, these being central policy goals in both the United States and Europe (National Science and Technology Council 2018; European Commission 2020). Having more scientific knowledge and people working in STEM not only raises wages at the individual level (Hastings et al. 2013; Kirkeboen et al. 2016; Deming and Noray 2020) but also fosters innovation, enhances labor productivity, and stimulates economic growth (Griliches 1992; Jones 1995; Kerr and Lincoln 2010; Peri et al. 2015).

Furthermore, the findings of this study challenge the notion that reforms in education standards have no meaningful impact on students, as prevalent in the academic and political debate. It has been argued that, in reality, there is limited scope for education standards to affect teaching, due to the dominance of other factors, such as the teachers' personal ideologies regarding curriculum designs in school (Moore et al. 2003; Loveless 2021). Still, legal pressures on school districts to follow education standards, the reflection of the content of such standards in textbooks, as well as the gradual expansion of standardized testing covering the content of these standards have arguably incentivized teachers to follow them.

The implications of the findings reach beyond evolution teaching in the United States. First, the fact that education standards lastingly shape students' beliefs even on a highly charged topic like evolution suggests that the effects on less controversial topics might be even larger. Second, the findings may also have a bearing on other countries where the teaching of evolution is controversial, such as most countries in the Middle East. Overall, fostering scientific attitudes and attracting STEM workers through education may enhance the technological progress that is required to overcome some of the great challenges of our time such as energy transition, combating climate change, and digitalization.

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Lilith Burgstaller and Sarah Necker

How to Incentivize Tax Compliance when Households Demand Services? What Works (Better) and General Limitations*

KEY MESSAGES

- Several countries use household tax credits to incentivize tax compliance in the provision of household services
- Tax credits increase households' willingness to pay for an invoice; however, the effectiveness depends on their design
- A tax credit that makes the financial benefit salient to consumers is most (cost-)effective
- Governments should consider that tax credits are related to high windfall effects

During the recent crises, governments around the world have spent large amounts of public funds to limit the impact of economic downturns on citizens and corporations. The resulting pressure on public funds is highlighting the crucial need to improve tax compliance. For instance, in the European Union, Member States lost an estimated 134 billion EUR in Value-Added Tax (VAT) in 2019, partly because of VAT fraud and evasion (European Commission 2021). Previous research shows that taxes are less likely to be evaded if governments can observe transac-

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tions (e.g., Kleven et al. 2011; Pomeranz 2015; Naritomi 2019). Thus, withholding taxes and verifiable documents are central instruments for successful tax collection. However, although the VAT provides an incentive for firms to request an invoice in business-to-business transactions, the same does not exist in business-to-consumer transactions. Consumers usually do not benefit financially from asking for an invoice. Yet, they may receive a price discount if they agree to proceed without a paper trail (e.g., European Commission 2014). The incentives to evade collaboratively are particularly high when sellers and consumers interact directly, such as in the provision of services to households.

To increase tax compliance in the provision of services to households, several countries have introduced policies to encourage consumers to demand legally provided services. Since the lower price is an important determinant of the decision to demand undeclared goods or services, the goal of these policies is to reduce the price premium for declaration. These policies include tax credits that offer favorable tax treatments to consumers of services, social vouchers which recipients can buy at low prices to pay for household services, and government lotteries for consumers who collect invoices. However, systematic evidence on the effect of such policies on households' willingness to demand declared work is rare.

In our paper (Burgstaller, Doerr and Necker 2023), we study the effect of monetary incentives on consumers' willingness to choose legally provided services using an experimental survey. We focus on tax credits, as granted in several European countries (OECD 2021). Tax credits take different forms, which may influence their effectiveness. In several countries, e.g., Germany, Italy, Belgium, and France, tax credits can be claimed via the annual tax return, which requires consumers to pay the full price upfront. It has been acknowledged that this implementation may lead to a low take-up rate among households with lower incomes, who cannot afford to pay the higher price of declared services upon consumption.

In addition, the procedure to obtain the tax credit may be too burdensome for some households. Therefore, Sweden has shifted to a system in which tax credits are granted at source, i.e., as an immediate price reduction at the time of purchase. In this system, the seller handles the administration with the tax authority directly. In our study, we compare the effectiveness of these two types of credits. Even the tax credit granted at source may be related to obstacles for households, e.g., if they lack the mathematical skills to calculate their benefit. In Sweden, some websites display the price including the tax credit (e.g., <https://www.hemfrid.se/en>). We examine how the effectiveness of tax credits changes when consumers do not have to calculate the final price themselves, but the financial benefit is made salient to them.

Another feature varying across countries is the rate of the refund. For instance, while in Germany consumers receive 20 percent of the labor cost as a refund, this rate is 50 percent in France or Sweden (OECD 2021). We study the effect of increasing the financial attractiveness.

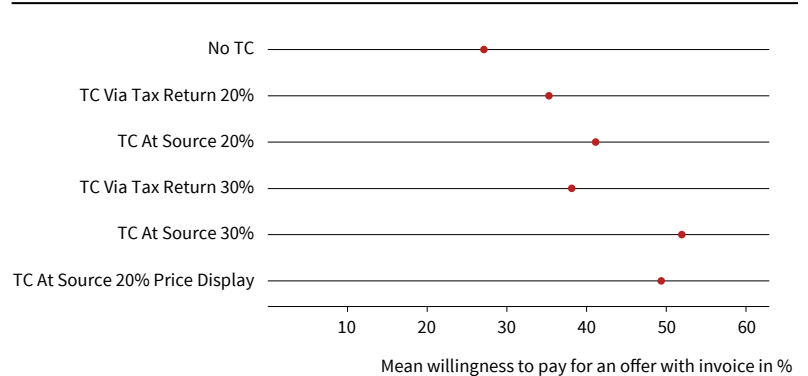
Our study is based on two surveys, in which in total 1,974 German homeowners participated. In these surveys, households are given the scenario that they want to hire someone to provide a service in their household, e.g., painting walls. Therefore, our results apply, in particular, to simple, small-scale jobs. Participants are asked multiple times to choose between two offers that vary the price, whether or not the service is with invoice, and other features. Each participant makes decisions under one of six policy scenarios, i.e., tax credits. They are either in a setting without a tax credit, with a tax credit that can be claimed via the tax return with a refund rate of 20 or 30 percent, a setting with a tax credit granted at source with a refund rate of 20 or 30 percent, or with a tax credit granted at source with a rate of 20 percent and where the final price, i.e., financial benefit, is displayed to participants.

TAX CREDITS INCREASE THE DEMAND FOR LEGALLY PROVIDED SERVICES

Our study shows that the most important determinant of respondents' decisions is whether an offer includes an invoice. When there is no tax credit, consumers are willing to pay a 27 percent higher price for the provision of the service if the offer is with invoice, as shown in Figure 1. Households are also willing to pay a higher price for an offer when the seller is recommended by acquaintances (versus no recommendation) and when the seller is available as desired (versus later). However, these characteristics are less important than receiving an invoice.

All types of household tax credits increase the willingness to pay for offers with invoice. A tax credit via tax return with a refund rate of 20 percent increases the willingness to pay for an invoice by eight

Figure 1
Premium Households are Willing to Pay for an Invoice under Different Tax Credits



Source: Authors' calculations.

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percentage points (ppts). That implies that under this tax credit, households are willing to pay a 35 percent higher price for an offer including an invoice. A tax credit granted at source with a refund rate of 20 percent increases the willingness to pay by 14 ppts. Hence, households are willing to pay a premium of 41 percent when the offer includes an invoice. While the effectiveness of the two different tax credits is not significantly different when the refund rate is 20 percent, we find a significant difference when the refund rate is 30 percent. Households are willing to pay a premium of 38 percent for an offer including an invoice when the tax credit can be claimed via the tax return and a premium of 52 percent when the tax credit is granted at source. Increasing the refund rate of the tax credits from 20 to 30 percent increases the effectiveness of the subsidy when it is granted at source but not when it can be claimed via the tax return. The results suggest that there is an interaction between the rate of the tax credit and its administrative implementation.

Displaying the final price of an offer with invoice leads to a similar increase in the willingness to pay as increasing the rate of the tax credit from 20 to 30 percent. Consumers are willing to pay a 49 percent higher price when there is a tax credit at source of 20 percent and the final price is displayed. This implies that governments can achieve the same effect when they provide a ten ppts lower tax refund and ensure that households understand the financial benefit.

We investigate the probability that the respondent chooses an offer including an invoice across the prime premia that consumers have to pay to receive an invoice. Unsurprisingly, the probability to choose an offer with invoice decreases when the premium increases. Remarkably, some households prefer offers without invoice even when their price is higher. This suggests that for some consumers, attributes such as the recommendation or availability of the seller are more decisive. We find that the effect of the tax credit is lower when the price premium increases. This is plausible since the share of the premium that is compensated by the tax credit decreases with the price difference. Hence, the likelihood that households

demand declared work depends on the premium suppliers request for an offer with invoice.

HOUSEHOLDS' WILLINGNESS TO PAY FOR AN INVOICE IS LESS THAN THE FINANCIAL VALUE OF THE TAX CREDITS

We compare the observed increase in the willingness to pay induced by the tax credits to the increase expected if individuals fully factored in the financial benefit of the tax credit. A tax credit reduces the price of an offer with invoice by 20 percent or 30 percent. This implies that for households using the tax credit of 20 or 30 percent, respectively, the price of an offer with invoice can be 25 or 43 percent higher to be even with the price of an offer without invoice. We find that with regard to the tax credit claimed via the tax return, the willingness to pay increases by only 26 percent (20 percent refund rate) and 20 percent (30 percent refund rate) of what we would expect if individuals would fully factor in the financial benefit. This fraction is 45 percent (20 percent rate) and 46 percent (30 percent rate) when the tax credit is claimed at source. When we additionally display the final price including the tax credit, we find that the willingness to pay is 71 percent of what we would expect when individuals would make their decision by purely focusing on the financial benefit of the tax credit.

The results suggest that compliance costs exist. However, they vary with the design of the tax credit. In line with our expectations, the more “user-friendly” tax credit granted at source seems to reduce those costs. Displaying the price, i.e., removing behavioral barriers such as poor mathematical skills, further reduces compliance costs. The last result confirms that governments should rather use strategies to help people understand the financial benefit from tax credits than increasing their rate to increase the effectiveness of such measures.

EXPLANATIONS FOR THE LOW TAKE-UP RATE

Our results show that households respond to tax credits by increasing the demand for offers with invoice. Although we would expect that a more “user-friendly” design and a higher refund rate of the tax credit increases its attractiveness, we only find that when two attractive features come together (high rate and when the tax credit is granted at source) the willingness to pay for an offer with invoice increases significantly. A possible explanation is that households are rather indifferent towards the implementation and mainly care whether or not they receive a refund at all. Indeed, about one-fourth reports that the introduction of a tax credit would not affect their behavior. Our survey further reveals why consumers may be hesitant to use the tax credits. Participants most important concern is that the seller may increase the price in return for the tax credit. Other concerns are that the seller has

more work or could withdraw the offer when they learn that the household would like to use the tax credit. This suggests that households may refrain from using tax credits because they are concerned about the consequences.

TAX CREDITS ARE SUBJECT TO WINDFALL EFFECTS

Our study shows that even without a tax credit, on average, in 55 percent of decisions households choose an offer with invoice. As shown above, with a tax credit, this fraction increases depending on the design of the tax credit. Even though the tax credit thus increases the probability that households demand an offer with invoice, it also implies that tax credits are associated with windfall effects, defined as the fraction of households that claim the tax credit even though they would have selected an offer with an invoice even without a tax credit. Our survey suggests that between two-thirds (less effective tax credits) and three-fourths (more effective tax credits) of participants would have asked for an invoice in any case. For these households, governments take into account a reduction of governmental revenues without inducing a change of behavior, at least regarding the choice between a legal and an illegal offer.

CONCLUSIONS AND POLICY IMPLICATIONS

Our study yields two main conclusions and policy implications. First, our results show that households have a higher willingness to pay for offers including an invoice when any kind of tax credit exists. Although this suggests that tax credits are effective in reducing the demand for illegally provided services, it has to be considered that the willingness to demand legally provided services is already substantial when no tax credit is in place. Relative to this baseline probability, the increase in tax compliance is modest. That implies considerable windfall effects. Two out of three respondents report that they would claim the tax credit even though they also would have selected an offer with invoice without the subsidy.

Note that our results apply to the provision of small-scale jobs in the household, such as painting walls. We expect that the baseline willingness to demand offers with invoice is even higher for larger jobs, for which having a guarantee or a paper trail is important. This may further question tax credits' effectiveness in inducing a change of behavior, at least regarding the declaration of the work. Due to the substantial windfall effects, governments that still want to use household tax credits should make sure that they design the instrument in a way that is most (cost)-effective.

Second, in this regard we find that households respond to the design of the tax credits, but only when different attractive features such as a high rate

and “consumer friendly” implementation come together. Displaying information on the final price that consumers have to pay including the tax credit, i.e., making the financial benefit salient produces a similarly strong effect as an increase of the refund rate by ten percentage points. This suggests that compliance costs, such as the bureaucratic burden to receive the refund, are substantial. The gap between the willingness to pay and the financial value is lower when the tax credit is more “consumer-friendly.” Even though the procedure to obtain a tax credit that can be claimed via the tax return has been kept simple, households seem to associate higher costs with them.

We conclude that if – despite their windfall effects – governments want to use tax credits, they should focus on an implementation which allows households to easily understand the financial benefit rather than trying to improve the attractiveness by increasing the rate of the refund. A possibility to implement this would be to require sellers to also state the final price, i.e., including the tax credit, in the offers they make to households.

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Justyna Klejdysz

Narratives in ECB Press Conferences: A Textual Analysis*

KEY MESSAGES

- **Topic analysis of the European Central Bank (ECB) press conferences reveals meaningful communication patterns**
- **Similar press conferences are clustered in time**
- **The revisions to the ECB narrative accompany the changes in policy direction**
- **Market volatility increases when the ECB substantially updates its wording in the monetary analysis section as compared to keeping it rather static relative to the previous period**
- **Shifts in ECB communication introduce incremental volatility above and beyond that created by a change in policy stance**

Communication is essential for central banks. As Ben Bernanke, former chairman of the Federal Reserve (Fed), famously said, „monetary policy is 98 percent talk and 2 percent action.“ Providing clear and consistent explanations to monetary policy decisions can significantly improve the efficiency of monetary policy (Blinder et al. 2008). Communication has become a monetary policy tool on its own because it has the power to improve the alignment of market expectations with policymakers' intentions.

Many central banks release statements after monetary policy decisions. Often policy statements are updated only marginally from meeting to meeting. Even small updates are scrutinized by financial market participants. There are various tools to „track changes“ with side-by-side statement comparisons, such as the Wall Street Journal's Fed statement tracker. Recent examples include the Fed's narrative of „transitory inflation“ in 2021 that generated substantial media attention. The Federal Reserve Chair eventually abandoned the keyword in November 2021.



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*The underlying paper is „Shifts in ECB Communication: A Textual Analysis of the Press Conferences“ by Justyna Klejdysz and Robin Lumsdaine, forthcoming in *International Journal of Central Banking*.

For the European Central Bank (ECB), the press conference immediately after the Governing Council meeting is the primary communication device. It consists of a prepared statement explaining the decision, followed by a Questions and Answers session with journalists.

Our paper quantifies ECB communication on the Governing Council meeting days. The key questions we address are as follows: What are the main communication patterns in the ECB press conference? Do shifts in communication patterns affect stock market volatility on the Governing Council meeting days? Using the algorithms for text data, we link the press conference text features to financial market reactions. Here we show that topic models can be used to identify different phases in ECB communication and that transition to a different phase in communication increases market uncertainty. This holds for the substantial updates to the prepared introductory statement, specifically in the section dedicated to monetary analysis. We also analyze the changing topical composition of the Q&A session; however, we do not find that changes in topics in this section on its own affect the market uncertainty.

DATA

We analyzed 156 press conferences from January 2004 to April 2018, spanning Trichet and Draghi's tenure. The press conference had a standardized structure over this time and consisted of six major parts: (1) summary of the ECB's monetary policy decision; (2) economic analysis; (3) monetary analysis; (4) cross-check paragraph; (5) fiscal policy and structural reforms; (6) questions-and-answers (Q&A) session. We treated sections as separate documents.

To decrease the vocabulary size, we applied standard preprocessing steps. First, we removed common introductory sentences. Then, we lowercased each word, and removed punctuation and stop words (i.e., words like „the“ or „and“) and words containing non-alphabetic characters, with some exceptions, such as money aggregates (M1, M2, M3). All terms were then lemmatized; that is, reduced to their dictionary form. Finally, we constructed a dictionary of n-grams, which are multi-word expressions consisting of words that often co-occur, such as „covered bond.“ The text after preprocessing was converted to a document-term matrix, where each row represented

a single document (a section on a given press conference day), each column corresponded to a unique term, and the frequency of a term in a document was in a cell.

We used daily closing values of the VSTOXX index to measure investors' reaction to ECB communication patterns on press conference days. The VSTOXX index represents the implied volatility of the Euro Stoxx 50 index and reflects market expectations of near-term volatility.

TOPIC MODELING

Topics are latent dimensions underlying texts. The idea behind topic modeling is to find the underlying topics in a set of documents based on the frequency of terms used in each document (encoded in the document-term matrix). We used Latent Dirichlet Allocation (LDA) developed by Blei et al. (2003) to find the latent topics in the ECB press conferences. We estimated LDA separately for each section to track the topics within sections and compare the changes across sections.

LDA models the distribution of latent topics in documents. Topics are represented by probability distributions over words. An optimization algorithm finds underlying topics and the associated word probabilities. The more often two words co-occur in a document, the more likely those two words are under the same underlying topic. The implementation of LDA requires the following two hyperparameters: The first hyperparameter controls how many topics can be in one document, the second hyperparameter controls how many words can be in one topic. In a standard implementation, these hyperparameters are selected in advance. Our improvement over this baseline specification was estimating them in a fully Bayesian manner using Metropolis-within-Gibbs sampling.

Another important modeling decision is how many topics to choose. We selected the number that yields the highest coherence and exclusivity (Roberts et al. 2014). Coherence measures the extent to which the most probable words in a topic co-occur within the same document, whereas exclusivity measures the extent to which the most probable words in a topic are not the most probable in other topics.

FINDINGS

Finding 1: Topic model reveals different phases in ECB communication

We find that document-topic distributions are generally sparse in all sections. Usually, a single „topic“ dominates a section, suggesting that change in topics over time indicates substantial updates to the section's content. We interpret the topics as different phases of ECB communication.

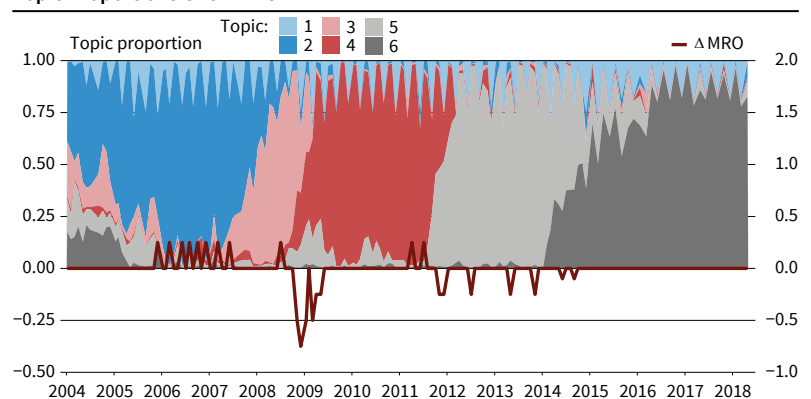
Historically, the ECB has relied on „two pillars“ for decision-making: the „economic analysis“ and the „monetary analysis.“¹ These two analytical perspectives are discussed in the corresponding sections of the press conference. Here, we take a closer look into the discourse in these two sections. In the analysis of the economic analysis section, we interpreted the topics by comparing them to changes in the ECB monetary policy stance. In the analysis of the monetary analysis section, we focused on the differences between topics before and after the turning points in communication.

Figure 1 shows how the proportions of topics in the economic analysis section evolved over time, along with the changes in the Main Refinancing Operations Rate (MRO). Specifically, there are the following topics:

- Topic 1: Macroeconomic projections, which are discussed quarterly. This is indicated by top terms such as „macroeconomic projection,“ „range,“ and „revise.“
- Topic 2: Positive economic outlook is emphasized during the tightening phase 2005–2007. The topic is mostly characterized by terms such as „robust,“ „favorable,“ and „efficiency.“ It declines shortly after the sequence of the rate hikes.
- Topic 3: The wage-price spiral, about which concerns appear during the first phase of policy responses to the financial turmoil, but in general, the fundamentals of the euro area economy were described as „sound.“
- Topic 4: Financial system stimulus discussion surged in November 2008; at the first press conference, the ECB announced cutting its key interest rate by 50 basis points after the Lehman collapse. Distinctive for this phase is a discussion about „financial system“ and „stimulus.“ This phase ended with two interest rate increases in April and July 2011.

¹ The new communication strategy, which started in 2021, refrains from this explicit division into two pillars and presents an integrated analysis.
Figure 1

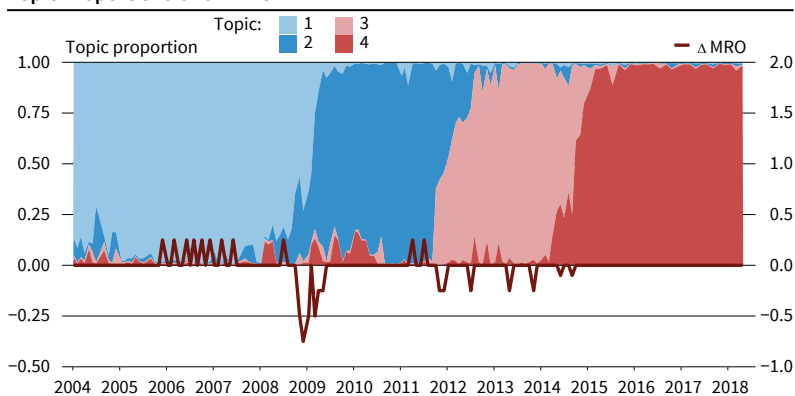
Economic Analysis Section and the ECB Interest Rate Decisions: Topic Proportions Over Time



Note: ΔMRO denotes a change in the Main Refinancing Operations Rate
Source:

Author's calculations (2022).

Figure 2
**Monetary Analysis Section and the ECB Interest Rate Decisions:
 Topic Proportions Over Time**



Note: ΔMRO denotes a change in the Main Refinancing Operations Rate
 Source: Author's calculations (2022).

- Topic 5: Negative economic outlook phase, which marks the start of the recession in the third quarter of 2011. It is characterized by the words „weak,“ „low level,“ „modest,“ „insufficient,“ and „slow.“ This phase is associated with the easing cycle.
- Topic 6: The recovery theme emerged gradually as the interest rates approached the zero lower bound. The predominant keyword is „monetary policy measure.“

Figure 2 shows topics in the monetary analysis section. This section's turning points in narratives are October 2, 2008, November 3, 2011, and May 8, 2014. Specific sentences repeatedly appear before the shift and are replaced by different commentaries after the turn.

- Topic 1 plummeted on October 2. Before this date, the ECB repeatedly pointed at prevailing upside risks to price stability, underlying strong

monetary expansion, and temporary factors which may overstate its impact.

- Topic 2 emerged as the financial market turmoil intensified. The ECB spent more time explaining substitution effects, discussing the diminishing impact of upside risks to price stability, and the impact of financial market tensions.
- Topic 3 emerged, starting with the statement from November 3, 2011. It was also the first statement under Draghi. Several statements before this date described the moderate monetary expansion and ample monetary liquidity that can accommodate price pressures. After this date, the ECB focused more on factors related to the increased financial market tensions related to the European sovereign debt crisis and their adverse effects on monetary developments.
- Topic 4 emerged in May 2014, which was the last month of positive deposit rates. Before May 8, 2014, the ECB repeatedly expressed its concerns about the transmission of monetary policy to the financing conditions in euro-area countries, the fragmentation of euro-area credit markets, and the resilience of the banking sector. Starting in June, a comprehensive package of non-standard policy measures was gradually introduced to improve credit conditions.

Finding 2: Shifts in ECB communication influence market volatility

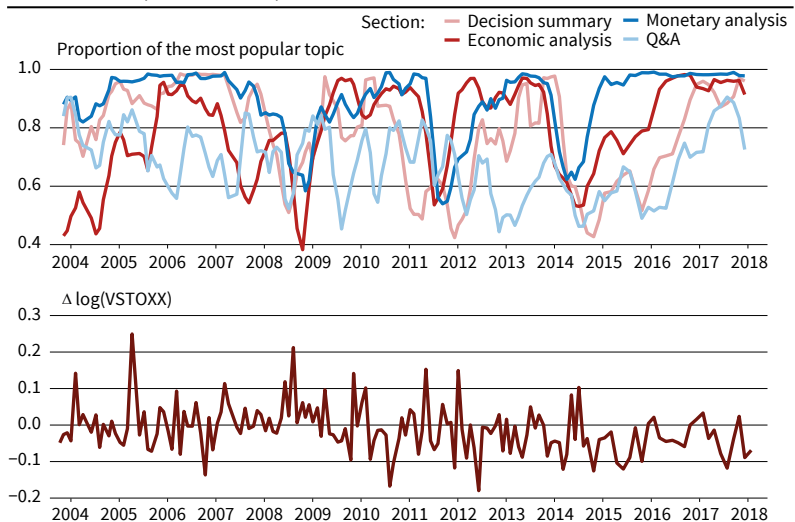
The analysis of the topics in different sections over time reveals different communication regimes. Transitions between those regimes are sharp and often occur at approximately the same time in different sections. Do the transition periods increase market uncertainty?

We exploited the shifts in the topics and constructed a measure of changes in communication which is the proportion of the most dominant topic on a given press conference day in a section. Figure 3 shows our topic-based measure of the homogeneity of discussion in a given section. High values of this score imply high homogeneity of discussion; lower values imply transition periods between different communication phases. The advantage of our measure of discussion homogeneity is that it does not rely on subjective topic interpretations.

We used an event-based regression framework where we focused on press conference days. We regressed VSTOXX changes on the homogeneity of discussion in different sections, controlling for surprises in the main refinancing operations rate (MRO), announcements about non-standard monetary policy measures, tone of the statements (positive/negative), and other variables.

We show that the major transitions in ECB communication regarding monetary analysis contain new and/or additional information about monetary policy

Figure 3
Homogeneity of Topic-based Communication Measures in ECB Press Conference (Top Panel) and the Daily Percentage Change (Close to Close) of the VSTOXX (Bottom Panel)



Source: Author's calculations (2022).

decisions. The uncertainty proxied by the VSTOXX index is on average lower when the ECB sends a homogeneous message (single topic dominates) than in times of transitions to a different topic. The implied volatility on the press conference day decreases by approximately 1.16 percentage points when the proportion of the most dominant topic in the monetary analysis section increases by ten percentage points. For reference, the standard deviation of the percentage change in VSTOXX over the analyzed period was 6.6 percent.

POLICY CONCLUSION

Our model of the ECB press conferences demonstrates that specific sentences, phrases, and themes are persistent over time and repeated from statement to statement. This persistence reflects the effort to make communication simpler and predictable; however, the statement is updated more substantially at some points. These shifts are informative for the market beyond policy decisions because they point to a new economic or monetary policy challenge or a change in market environment. In particular, the revisions to the monetary analysis section, which describes

the current course of the monetary policy, increase market uncertainty. The finding is reminiscent of that of Ehrmann and Talmi (2020), who found that market volatility decreases when consecutive central bank communications are semantically similar or similar in wording. The reaction may indicate that new content is more difficult to digest for market participants. However, this paper focuses on within-statement coherence and does not explicitly consider cross-statement similarity. Our findings also demonstrate the ability of topic models to detect new policy narratives.

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