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# Statistical data needs on sustainable finance for central banks[1]

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[1] This presentation was prepared for the conference. The views expressed are those of the author and do not necessarily reflect the views of the BIS, the IFC or the central banks and other institutions represented at the event.

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## Abstract

The negative impact analysis of the climate change on the whole economy is particularly relevant for the central banks since they produce and use data before implementing the monetary policy to ensure the financial and prices stability and therefore mitigate the systemic risks in order to participate to build a healthy and resilient financial system. The goal of this paper is to discuss the development of sustainable finance database in accordance with the central bank's needs and propose some key recommendations at least in the short run to partly overcome the database lacuna. After having attempted to capture the notion of sustainability and briefly describe the ESG (Environment, Social and Governance) criteria, we justify why the central bank needs reliable sustainable financial data for their potential monetary policies to fight against the climate change, for instance. From this definition attempt, several important conclusions have emerged such as the harmonized taxonomy unavailability and the lack of reliable data to measure with accuracy the climate change impacts on the financial and economic sectors, for instance. To reduce the data gap, there are different European initiatives, and more particularly Luxembourgish ones, aiming at building sustainable bonds database to capture the nature and the size of such sophisticated financial tools. The sustainble bonds are financial instruments that permit to finance investments in line with the ESG criteria. We have found that there is an exponential development of the sustainable bonds market, witnessing the increasing investor's interest, and this rising trend has been taking shape in Europe since 2013. All European individual efforts against data lacuna are, of course, welcome and useful; however, they should be ordered and targeted according to the users' needs and the economic, financial, sanitary and social context to define and develop at the very short term a public, detailed and comprehensive ESG data repository (at granular and aggregated levels); since the reliable database existence is the cornerstone of any regulation and policy. Finally, as the climatic warming is global, the data storage project should lead to an international collaboration to define a common set of standards, to benefit from the scales and synergies advantages and to limit the redundant initiatives.

Keywords: sustainability, surveys, users statistical needs, central banks, Luxembourg sustainable bonds, recommendations.

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# 1. Introduction

The 2008 Global Financial Crisis (GFC) followed by the sanitary crisis has demonstrated that the funding system of production has reached its limits. Moreover, several climate reports warned governments about risks to continue to finance real sphere without controlling for the CO2 emissions, for instance. The most important decision was to reduce the high carbon production to limit the climate change and to ensure an optimal ecological transition. Since the COP21, the climate target is to reduce the increase in global temperature by 2100 (below 2°C above pre-industrial levels and even further to 1.5°C according to The Paris Climate Agreement, 2016). The Paris Agreement (PA) entered into force on 4 November 2016 and it has been signed by 195 countries[2]. It defines guidelines to achieve the climate targets and proposed a calendar. The PA considers that a negative externality, such as pollution is a wheel to the economic growth. Quite a few theories have shown that the natural resources are engines for growth. One of the most ancient approaches is the physiocraty theory. The Nobel Price economist in 2018, William Nordhaus has analyzed the role of climate change in the economic growth during the years. He was a pioneer in this field and his works have clearly described the channels between the economic growth and climate change. Nowadays, there are various attempts to describe and find solutions for a greener finance system based on empirical analysis (Nordhaus and Tobin, 1973; Nordhaus, 2006; Abraham and Mackie, 2006; Aglietta and Rigot, 2012; Jeffers, 2015; Kempf, 2017; Muller, 2014 and 2019; Belloni et al. 2020; Ehlers et al. 2020; BIS 2020; IMF, 2020; Gilchrist et al. 2021). However, the first difficulty is to accurately define the sustainable/green finance. There is until now no consensus on the definition and no definitive taxonomy. Currently, the sustainable activity may be summarized by several private or public agencies approach. "Financial products & services that consider environmental factors throughout the lending decision-making, ex-post monitoring, and risk management processes, to promote environment-responsible investments and encourage low-carbon technologies, industries and businesses" (Pricewaterhouse Coopers Consultant, 2013). In 1987, the United Nations Brundtland Commission defined sustainability as "meeting the needs of the present without compromising the ability of future generations to meet their own needs. These two definitions are similar but raise the question of the development of metrics to capture the size of the sustainability.

The current perimeter is too broad and therefore not very relevant for users and may develop free riders behaviours. For instance, there is no official set of variables to measure accurately the degree of "greenness" or more globally sustainability. In addition, the development of scoring agencies assumed to evaluate the level of greenness reveals that there are plenty acceptance thresholds for the notion of low-carbon, for instance. Some projects would be classified as low carbon projects by some rating agencies whereas for other agencies, they would be considered dangerous for the planet. Such a diversity in classification raises the concerns about free riding behaviour and the quality database?

During years central banks have saved the financial system by using and defining traditional and non-conventional tools, namely quantitative easing; low (even negative) interest rate policy etc. They have also enlarged their missions after the last financial crisis by guaranteeing the financial stability. Given the history and the role of the central banks during the financial crisis, it is normal that the central banks tackle the climate change; however, they should not be alone for this task. Despite the several debates on the central banks missions, it is obvious that they can fully play their role of regulators as underlined by Frank Eldernson, member of the executive board of the ECB, "the ECB's environmental action is fully

[2] https://www.un.org/en/climatechange/paris-agreement#:~:text=The%20Paris%20Agreement%20formally%20entered,189%20have%20ratified%20the%20Agreement.

in line with its mandate". Moreover, there are an explosion of statics production from the central banks and this trend is reinforced by the last sanitary crisis since during this specific context, an important need of timely and reliable database in order to define their policies aiming to support economic growth. Indeed, according to Tissot and De Beer (2 020), the consequences of the last sanitary crisis on public statistics have demonstrated the necessity to develop reliable databases for all users, and more particularly for the central banks that are the main actor to save and stabilize the financial system and *in fine* support growth and promote employment. Central banks have a very long and qualitative experience of producing reliable data and providing transparent information on the data definition, scope, metrics etc. This COVID-19 episode has shown us how it is important to provide qualitative, flexible and transparent statistics in order to fully understand the interaction of variables to propose adequate policy, for instance. One of the most important challenges for the central banks is to develop the statistics scope and publish on a regular basis several sustainable statistics to be used by policy makers, analysts and academics. The development of hubs including all sustainable actors is suitable to create a real dynamics and improve the production and the use of statistics.

This paper starts by examining the concept of sustainable finance. Soon, we face the difficulty to define the socially responsible finance. Should we use a broad definition or a taxonomy approach? Here, the fundamental question is also how to measure with accuracy the sustainable finance scope. The third section exposes why the central banks (CB), or legal authorities should, as financial and prices stability guarantors, cope with data gap. It also underlines the necessity to develop the database to assess/monitor the evolution of the sustainability perimeter to satisfy the users' needs that are paramount. The same section describes some data building initiatives to improve the availability of the sustainable bonds database. In the last section, we propose some recommendations (on approaches, on metrics, on tools, etc.) to deal with the data gap that handicaps the development of reliable empirical works to support the green finance, for instance and it proposes a provisory road map. However, given the relative new problematics, several improvements are expected, particularly in the period length and scopes. The last section also concludes on the next steps to reduce the data gap, to reinforce the quality of the available databases and to share the databases with all users. This point also raises the questions of the international cooperation as the climate change is global, moreover, the nations will benefit from the scales and synergies advantages.

## 2. How to apprehend the sustainability notion: definition vs taxonomy

The aim of this section is twofold. The first one is to demonstrate that sustainable finance debate is still developing under a context of the emergency of the climate change. This statement has contributed to a recognition that we cannot be passive towards the environmental risks in particular toward the threats of climate change. This awareness has developed plenty of initiatives both private (scoring agencies) and public (central banks, International and European institutions, Non-Governmental Organization, States etc.). Rapidly, various criteria assumed to characterize sustainable finance have emerged. Among the most famous criteria, we present the Environmental Social and Governance (ESG) criteria. Nevertheless, we have noticed that notwithstanding the world efforts to delimit the perimeter of the green finance, there is a disparity between countries in the green finance landscape. The most illustrative example is the Carbon prices that should be used to set up a tax policy. The World Bank dashboard launched in 2017 has shown that several methods exist and not all countries have a carbon price. Thus, it may contribute to a creation of free rider cases. With the electricity growth demand, it is obvious that it is tempting to set up where there is no (or weak) carbon price.

The second goal is to provide a clear framework of the green finance scope. A broad depiction to capture the complexity of the sustainable finance does not make sense since the devil hides in details. Nevertheless, the development of a harmonized taxonomy is assumed to be the best approach to fit the sustainable finance. We have to welcome the efforts of European Commission that have presented a pioneering taxonomy in its last green report published in March 2020. However, this taxonomy is far to describe the green finance heterogeneity and complexity.

There is still a long way to address the climate change and environmental risks that are a threat for the economic stability. The linkage between economic growth and sustainable finance cannot be fully understood if we do not agree beforehand on criteria of sustainable finance (clear, harmonized, accepted by all). The traditional finance has always played an important role in shaping the economic development. We should understand the ins and outs of the sustainable finance to analyze the impacts of green finance on Gross Domestic Product (GDP). When this is done, theoretical and empirical works in this field should skyrocket. Indeed, according to Hurley (2019), fixed-income investors have underlined that the lack of reliable ESG data is a barrier to taking into account in their portfolio this kind of financial assets.

## 2.1. Sustainability Background: Towards a Recognition of Sustainable finance

Sustainable finance takes into account environmental, social and governance (ESG) criteria relative to firm's decisions and investment strategies. It incorporates many issues from climate changes and pollution to labor practices, consumer habits, and firm's competitive behaviour etc. The following table provides information about the ESG issues.

ESG Issues Table-1-

| **Environment Issues** | **Social Issues** | **Governance Issues** |
|---|---|---|
| Climate change and Carbon emissions | Customer satisfaction | Board composition |
| Air and water pollution | Data protection and Privacy | Audit committee structure |
| Biodiversity | Gender and Diversity | Bribery and Corruption |
| Deforestation | Employee engagement | Executive compensation |
| Energy efficiency | Community relations | Lobbying |
| Waste management | Human rights | Political contributions |
| Water scarcity | Labor standards | Whistleblower schemes |

Source: Chartered Financial Analyst (CFA) Institute, Environmental, Social, and Governance Issues in Investing, A Guide for Investment Professionals, 2015, Page 4, Retrieved from: https://www.cfainstitute.org/-/media/documents/article/position-paper/esg-issues-in-investing-a-guide-for-investment-professionals.ashx

Efforts to introduce these kinds of concerns in finance began at least 30 years ago but nowadays there is an acceleration of the need to protect the planet. This increasing trend is likely related to the

Copenhagen Conference in 2009 and the Paris Climate Agreement (2015) and the will of most countries to reorient the "brown" production system towards a green one. Indeed, quite a few meetings/conferences and reports from international institutions have shed the light on the urgency to deal with the climate change and environmental degradation. The European Commission has called for a better respect of sustainability criteria to reduce environmental risks and avoidance of a systemic crisis (EC Report 2017)[3]. The EC's conclusion of the report is that the climate change has to be a priority. Indeed, in 2009, at the Copenhagen conference, some countries agreed to tackle the problem of climate change. They have proposed a target for the temperature evolution (less than 2 degrees Celsius, above 1880 levels). Scientists have noted that the world has experienced a warming of 0.8°C. Besides, recent reports produced by the Intergovernmental Panel on Climate Change (IPCC, from 2013 to now) have provided the scientific assessments. The reports have confirmed that natural systems is changing because of the greenhouse gas emissions (GHGs) that were particularly high between 2000 and 2010. Without further efforts, the planet will experience an increase of temperatures, from +3.7 to +4.8 degrees Celsius by the end of the century. The impacts on earth are obviously dramatic. An elevation of temperature has a direct implication in the agricultural sectors and the water availability. In 2013, the World Bank has ordered works to analyze the potential impacts of an increase in temperature of 4°C (World Bank Report, from 2012 to 2019). The results and conclusions are alarming. Concisely, in many cases, extreme heat waves, rising levels of the seas, more intense storms, droughts and floods will threaten the world in particular the poorest and the most vulnerable people[4]. In 2015, the governor of Bank of England, pronounced a discourse entitled "Horizons Tragedy Breaking the tragedy of the horizon – climate change and financial stability"[5]. This presentation echoed the "Tragedy of the common" written by Hardin in 1968. He shed light on the overuse of common resources since they were public goods. In his discourse, the governor has stated three types of risks related to the climate change. The physical risks appear when the climate change affects the production and financial spheres. Climate change creates new economic risks, namely negative evolution of the firms' productivity. Recommendation assets portfolio. The second risk is the transition risk. For instance, when a firm develops a low carbon strategy policy, the results are random. The effects on the economic growth and the financial system are long run frameworks. The third risk is the liability risk. The occurrence of natural disasters' trials is the main cause. The insurance sector is in the front line. Currently, the framework relative to the resilience of the insurance sector assumes that a low probability and a high severity have characterized catastrophic risks (Louaas and Picard, 2018). With the climate change, this hypothesis should be reconsidered. Today, the probability of a natural disaster is not so low and in the future, it will increase significantly. This assumption should be introduced in the insurance literature to elaborate worthy stress tests, for instance. Louaas and Picard (2018) have measured the insurance resilience to climate change risk. Stress tests are also interesting tools to quantify accurately how the financial and economic systems are harmed by an extreme weather events such as typhoons, earthquakes, for instance (EIOPA's dashboard, 2020)[6].

These quantitation exercises should take into account all institutional sectors and countries since they are all interconnected and the climate change is a global issue.

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3 https://ec.europa.eu/environment/enveco/sustainable_finance/pdf/studies/Defining%20Green%20in%20green%20finance%20-%20final%20report%20published%20on%20eu%20website.pdf

4 https://apps.who.int/iris/bitstream/handle/10665/134014/9789241507691_eng.pdf

5 https://www.bis.org/review/r151009a.pdf

6 https://www.eiopa.europa.eu/content/pilot-dashboard-insurance-protection-gap-natural-catastrophes_en

The three risks[7] mentioned above should be correctly analyzed to avoid the systemic risks. The climate change threats henceforth the financial and economic stability. Recognition of the emergency climate-related risks led to the creation of working groups, hubs or workshops. We can cite the initiative of the Financial Stability Board (FSB) in 2015. The FSB at the request of the G20 (Group of Twenty) created a task force dedicated to the analysis of the climate change (Task Force on Climate-related financial Disclosure (TFCD)). It has provided recommendations and disclosures to economic agents, such as investors, insurers, lenders, etc. In 2017 the central banks and Supervisors Network for Greening the Financial System (NGFS) appeared. In April 2019, the NGFS published a report[8] that states six recommendations in order to green the financial system. Four recommendation dedicated to supervisors, CBs, and the policy makers. The supervisors' recommendations deal with, roughly speaking, the incorporation of green micro and macro prudential tools in their missions and the development of a harmonized, accurate and reliable database. The information transparency and the data/ knowledge sharing is also required. The decision makers should develop a taxonomy of the green activities and should participate actively to the reliable climate and environment-related disclosure and guarantee the respect of climate rules.

Since December 2019, Christine Lagarde underlined the necessity to recognize the importance of climate-related risks. She also detailed three areas where the ECB should intervene (macroeconomic perspective, banks and financial portfolio). The ECB should introduce green variables for the forecasting growth exercises. It should advise banks on how to evaluate correctly the climate change risks. Stress testing exercises for banks are crucial for the financial stability. The ECB should privilege green assets in managing its pension portfolio. It is obvious that the EU is trying to find solution with ambitious policies, package and narrow collaboration with international partnership as reflected in the EU Green deal that aims to fight against climate change. The sanitary crisis demonstrates how the role of central banks is essential to guarantee the financial stability. Different measures have been urgently rolled out to preserve the proper functioning of European economies. The ECB has not hesitated to support actively and gradually European countries to counter the negative impacts of a potential systemic crisis, as witnessed by the ECB actions since the COVID-19 occurrence (Benigo et al., 2021).

All these initiatives have demonstrated that the urgency of the climate-related risks is publicly recognized. Nevertheless, the facts do not illustrate the urgency. Indeed, there is a kind of "ratchet effect". We are aware of the ecological risks but the CO2 emissions do not decrease drastically. Indeed, "the dataset (EDGARv5.0_FT) shows that global anthropogenic fossil CO2 emissions increased by 0.4% in 2016 compared to 2015 and a further 1.2% in 2017 compared to 2016 reaching 37.1 Gt CO2".[9] In addition, some works discuss the CO2 metrics and demonstrated that until now this variable is under evaluated in financial portfolio (Janssen et al., 2021). This means that the ecological transition will take time; it is a structural change. Remind that during centuries investors and firms have thought that the main engine of their wealth is the short-term profits perspectives. Firms and investors seek for maximum profits. The main factor to invest is the short-term yield. The financial component (F) is the principal motivation of investors. Investors and firms have to switch from a short-term profit maximization perspective to a long-term profit optimization perspective (Jeffers, 2015). The firms and investors should also take into account the ESG criteria in their optimization programs. A "mentality revolution/change" in favour of ecology is necessary. The sustainable development (SD) is function of at least three components (and not only financial motives).

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7 The European Commission considers there are two risks (physical risk and transaction risk) since the liability risk is included in the physical risk.

8 https://www.banque-france.fr/sites/default/files/media/2019/04/17/ngfs_first_comprehensive_report_-_17042019_0.pdf

9 https://edgar.jrc.ec.europa.eu/

$$f(SD) = f(F, Ec, S)$$

With $F$ = Financial concerns $Ec$ =Ecological concerns and $S$ = Social concerns.

Investors and firms should search for sustainability for at least three reasons. Sooner or later, the environmental taxes will exist in all countries (for example, the carbon tax). In addition, they have to program in advance their transition to Sustainable Development Goals (SDG) by 2030. Therefore, they should start to anticipate the new regulations. The second reason is the recognition of the importance of ecological and social risks by consumers and other non-governmental organizations (NGOs). The last reason is the moral responsibility that raised the question of liability risks. The costs of planet damages are huge and the taxpayers for fairness motives cannot always pay them (Jeffers, 2015).

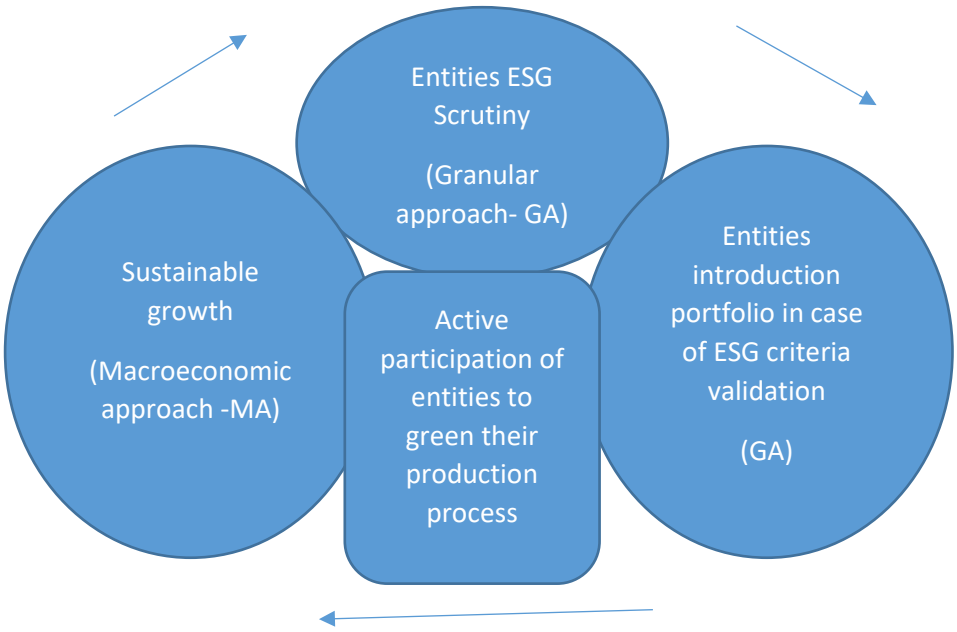
Nowadays, it is obvious that we cannot continue to produce without taking into account the negative externalities of the pollution, for instance the carbon overused in the world industry. The notion of growth's sustainability should be the leitmotiv of both producers and consumers. Behind the notion of sustainable growth, people are aware that the current economic growth is using services such as greenhouse gas-emitting energies, whose production gradually degrades the ecological environment. People are also aware of the fact that the depletion of natural resources or the very rapid deterioration of the planet threatens the future in terms of financial and economic stabilities. To restore sustainability, it is necessary to act on the demand for these services, or to intervene on the supply side by finding a more efficient way to produce. Likewise, the optimal composition of these two types of shares (demand and supply) depends on the comparison of demand elasticities for these services on the one hand, and substitutability degrees between green capital and natural resources, on the other hand (Bureau, 2014).

In addition, many studies have explored the notion of green production based on a new calculation of the GDP. Environmental accounts attempt to capture the interaction between production and environment. The environmental accounting tends to evaluate the depletion of resources or the planet degradation due to human (anthropocenic) activities (Apergis and Payne, 2010; Xu et al. 2010; Dubrocard and Prombo, 2012; Song et al. 2019). The cost of pollution is crucial for these kinds of exercises.

In all cases, ethical growth requires a reliable picture and an appropriate price signal for the damages caused by the firms and a granular approach is highly recommended. The green finance could fully develop if the concept of sustainable production had already existed. Most of the studies have encountered pollution valuation's problem hitherto. Yet, there is no consensus on the greenness level of production.

All points developed above are the matters of the policy makers and especially regulation and supervisory authorities. Their role in the environmental policies is important. Nevertheless, it is also necessary to monitor the redistribution's issues and guarantee the financing under good conditions of ESG investment. Hence, these policies should create a virtuous cycle of ecological investment (Figure-1- ).

Sustainable investments virtuous approach Figure – 1 –




Source: Author

Figure-1- displays the elements of the virtuous approach that finances firm's projects and in the end stimulates the sustainable economic growth. The corner stone of this process is the depiction of "green activities". How could the sustainable finance relaunch economic growth? This is not a marginal interrogation; for several years, we observe sluggish growth in Europe, despite the conventional and unconventional measures adopted by the European Central Bank (ECB) since the last financial turmoil. This situation may be recurrent. Indeed, the economic growth is not linear or endless. Some economies have weak growth rate because innovations are not sufficient to permit them to switch towards higher steady growth path. We call this kind of approach, the endogenous growth models. Before these models took prominence, the Solow (1956) and Swan (1956)'s theories have partly dominated the economic literature. However, soon also these models encountered the obstacles. Indeed authors assumed the convergence of all economies towards a unique equilibrium. The growth factors are exogenous such as population growth, for instance. The endogenous models are more flexible since internal forces, such opportunities to develop technological knowledge, govern the long-term economic growth. The equilibrium paths of growth are not unique and evolve each time there is a technical progress, for instance. To switch towards another equilibrium growth path, economies introduce externalities. The innovation is one of the best illustrations to materialize the externalities. Aghion and Howitt (1992) and Grossman and Helpman (1991) have proposed a version of innovation-based growth theory inspired by the Schumpeterian framework. This latter has insisted on the "quality-improving innovation" that destroys the old products because of its advanced obsolescence. For Schumpeter (1942), it is the process of "creative destruction". For decades, growth theorists have considered financial intermediation and innovation as externalities assumed to generate the economic growth. For illustration, Bencivenga and Smith (1991) have developed an endogenous growth model. They have introduced diverse assets with different degrees of liquidity. According to their model, the financial intermediations have promoted

growth and have reduced the unnecessary liquidation of capital that strengthens the economic growth. Rapidly, the financial literature has seized this topic and has improved it. Theoretical and empirical studies have incorporated banks, stocks market or any financial innovations in their models to investigate the link between the traditional finance and growth. However, the results are puzzling. Indeed, the interconnectedness between finance and GDP is sometimes positive and sometimes negative (Goldsmith, 1969; King and Levine, 1993; Levine and Zervos, 1998; Beck, Levine, and Loayza, 2000a-b; Xu 2000; Rajan and Zingales 2003; Gupta and Yuan.2009; Stiglitz, 2010; Ang, 2011; Rousseau and Wachtel, 2011; Leaven and Valencia, 2013; Leaven, 2014; Madsen and Ang, 2016; Strieborny and Kukenova 2016; Sbia et al., 2017; Gueddoudj 2017, 2018; Nyasha and Odhiambo, 2018; Eryılmaz et al. 2018). This ambivalence of conclusions should not be surprising since the economic growth depends on the financial development. Above a certain financial development threshold, the economic growth is slowing down and then decreases. This means that the finance and growth couple's interconnectedness is not linear. The recent literature tends to demonstrate that the traditional finance in the developed countries have a small impact on GDP. Indeed, since years in Europe, there is a sluggish growth (CNBS, 2020[10]; Jeffers and Goldman, 2021; Goldman and Zhang, 2021). A Schumpeterian framework may relaunch the debate of sustainable growth funded by financial ethical innovations.

Nowadays lots of studies and international reports underline the danger to continue to finance growth without taking into account the green perspectives (Aglietta and Rigot, 2012; Jeffers, 2015; Tirole, 2017; IMF Report, 2018-2019; World Bank Report, 2020; IPCC Reports. 2020-2021; Summit Common Good 2021; Green Swan 2 virtual conference, 2021; Blanchard and Tirole, 2021). As noticed above, the Schumpeterian theory may bring some theoretical explanations on the sluggish growth of European countries. The traditional finance may have reached its limits or it has likely reached its Golden Age. It is time now to find another type of financial innovation. Ethical finance may be the next step to recover growth. Nevertheless, both private and public actors should promote and support sustainable finance. Actions to preserve the earth is vital (Noh, 2010, 2018) because of the possible occurrence of systemic risks. Indeed, nowadays plenty of works have sought to estimate the loss of GDP lead by environmental catastrophes. For illustration, GDP losses caused by global warming are evaluated to 5% to 20% (IPCC, 2013; Stern, 2006). Moreover, the Joint Research Centre (JRC)[11] report has demonstrated that if there is no climate change measure to mitigate greenhouse gas emissions or finance the ecological transition. It has shown that the southern countries are more exposed and the climate change impacts are costly and irreversible. In addition, the EIOPA has proposed a provisory climatic change dashboard to evaluate the cost of the acute physical risks (floods, earthquakes, typhoons etc.).

It is now undeniable that the ecological concerns have skyrocketed in the theoretical framework and among the public. However, it is not sure that the current scope of analysis is optimal to develop the empirical works aiming to define sustainable policies.

The priority henceforth is to find accurate approach to capture the sustainable finance complexity and understand the transmission channels between growth and ecological finance.

## 2.2. Sustainable Finance Approach (es): Definition versus Taxonomy

Nowadays, we do not have a precise and commonly accepted definition of green finance for different reasons. Firstly, not all studies have provided a clear picture of sustainable finance. Moreover, even if

[10] https://www.cnbc.com/2020/03/04/euro-zone-growth-likely-to-slow-to-a-crawl-over-the-next-10-years.html
[11] JRC PESETA IV

there are incomplete concepts they differ from one analysis to the other. For instance, from 2013 to today, World Bank Group IFC (International Finance Corporation) proposed a bottom up approach to capture the notion of socially responsible (SR) finance. The IFC has enumerated diverse categories to delimit the ESG finance scope (Adaptation (conservation, bio system adaptation); Carbon capture and storage; Energy efficiency (cogeneration, smart grid) etc.)[12]. Seldom is there a unique responsible finance picture because of its multi-faced nature. Nevertheless, some authors or consultant agencies have tried to expose the concept of greenness. Table – 2- displays some definitions[13].

Sustainable finance definitions Table-2-

| Authors /Agencies | Definitions |
|---|---|
| 1- Pricewaterhouse Coopers Consultant (2013) | "Financial products & services that consider environmental factors throughout the lending decision-making, ex-post monitoring, and risk management processes, to promote environmentally-responsible investments and encourage low-carbon technologies, industries and businesses" |
| 2- The Climate Mundial (2020) | "Green finance refers to any financial instrument or investment – including equity, debt, grant, purchase & sale or risk management tool (for example: investment guarantee, insurance product or commodity, credit or interest rate derivative, etc.) – issued under contract to a firm, facility, person, project or agency, public or private, in exchange for the delivery of positive environmental externalities that are real, verified and additional to business as usual, whereby such positive externalities result in the creation of transferrable property rights recognized within international, regional, national and sub-national legal frameworks." |
| 3- Höhne et al.(2012) | "Green finance is a broad term that can refer to financial investments flowing into sustainable development projects and initiatives, environmental products, and policies that encourage the development of a more sustainable economy. Green finance includes climate finance but is not limited to it. It also refers to a wider range of „other environmental objectives, for example industrial pollution control, water sanitation, or biodiversity protection. Mitigation and adaptation finance is specifically related to climate change related activities: mitigation financial flows refer to investments in projects and programs that contribute to reducing or avoiding greenhouse gas emissions (GHGs) whereas adaptation financial flows refer to investments that contribute to reducing the vulnerability of goods and persons to the effects of climate change." |

12 https://www.ifc.org/wps/wcm/connect/12ebe660-9cad-4946-825f-66ce1e0ce147/IFC_Green+Finance+-+A+Bottom-up+Approach+to+Track+Existing+Flows+2017.pdf?MOD=AJPERES&CVID=lKMn.-t

13 The list of the definitions is not exhaustive.

| | |
|---|---|
| 4- Zadek and Flynn (2013) | "Green finance is often used interchangeably with green investment. However, in practice, green finance is a wider lens including more than investments as defined by Bloomberg New Energy Finance and others. Most important is that it includes operational costs of green investments not included under the definition of green investment. Most obviously, it would include costs such as project preparation and land acquisition costs, both of which are not just significant but can pose distinct financing challenges". |
| 5- Organization for Economic Cooperation and Development (OECD) | Green growth ... is about fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. It is also about fostering investment and innovation, which will underpin sustained growth and give rise to new economic opportunities … policy action requires looking across a very wide range of policies, not just explicitly 'green' (i.e. environmental) policies. (p.18) … the success of a green growth strategy will rest on addressing political obstacles and distributional concerns about the costs of change. (p.20) |
| 6- United Nations Environment Programme (UNEP) | A 'green economy' as one that results in 'improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities (UNEP, 2011, p. 16) … In its simplest expression, a green economy is low carbon, resource efficient, and socially inclusive. In a green economy, growth in income and employment should be driven by public and private investments that reduce carbon emissions and pollution, enhance energy and resource efficiency, and prevent the loss of biodiversity and ecosystem services. These investments need to be catalyzed and supported by targeted public expenditure, policy reforms and regulation changes. The development path should maintain, enhance and, where necessary, rebuild natural capital as a critical economic asset and as a source of public benefits. This is especially important for poor people whose livelihoods and security depend on nature. The key aim for a transition to a green economy is to eliminate the tradeoffs between economic growth and investment and gains in environmental quality and social inclusiveness…the environmental and social goals of a green economy can also |

| | |
|---|---|
| | generate increases in income, growth, and enhanced well-being. (p. 16). |

Source: Author

The overview reported in Table-2- is too general and does not display an accurate portrait of the green/sustainable/inclusive finance (definitions 1-3). Furthermore, the fourth definition has taken into account the reconsideration of other agency's approach such as Bloomberg or others. Lastly, the definitions 5 and 6, illustrate the varieties of the green concept.

It is obvious that these attempts are far from being adequate in covering the complexity of the sustainable finance and we need more studies about the ethical finance. Why should we condense the complexity of a variable into a unique definition (Lindenberg, 2014)? Is the taxonomy approach more advantageous?

Because of the difficulties to find a universally accepted definition, rapidly diverse institutions have preferred to construct a taxonomy.

The following paragraphs deal with the taxonomy, its goals and its limits in Europe.

Since June 2018, the Technical Expert Group on sustainable finance (TEG) has studied the possibility to set up a taxonomy assumed to describe with accurate the ethical finance. This expert group has been created due to the lack of universal SR finance image and the recognition of the climate change urgency. Indeed, all countries are aware that the global emissions should be divided by two over the next decade. However, the global greenhouse emissions are rising despite the scientists' alarmist reports (IPCC Report (2019)[14]. According to the same report, the impacts of climate change are likely irremediable if we do nothing to stop this trend.

This concerning context has lead several international organizations to define as soon as possible a taxonomy. Before presenting the main results of the EC report published in March 2020, we expose the purposes of a taxonomy. The taxonomy is a set of criteria/rules supposed to elaborate a classification to verify which activities are environmentally sustainable. Table-3- displays what a taxonomy is (or not).

Taxonomy Table-3-

| **IS** | **IS NOT** |
|---|---|
| A list of economic activities and relevant criteria | A rating of good or bad companies |
| Flexible to adapt to different investment styles and strategies | A mandatory list to invest in |
| Based on latest scientific and industry experience | Making a judgement on the financial performance of an investment – only the environmental performance |
| Dynamic, responding to changes in technology, science, new activities and data | Inflexible or static |

Source: European Commission, Retrieved from: https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/190618-sustainable-finance-teg-report-using-the-taxonomy_en.pdf

14 https://www.ipcc.ch/site/assets/uploads/sites/4/2019/12/02_Summary-for-Policymakers_SPM.pdf

The principal advantage of a taxonomy is its flexible nature. The criteria continuously evolve with the context and the knowledge progress. However, it may be not enough to evaluate correctly the risks related to environment since it does not take into account all risks. Moreover, the taxonomy does not cover all economic institutional sectors either.

In line with EC Reports, to be environmentally sustainable, activities have to be in conformity with EC regulation. The EC taxonomy takes into consideration diverse variables related to environment. Candidates for a "green passport" in accordance with the EC have to:

- Participate actively to the one or more environmental objectives defined by the Proposed Taxonomy Regulation (climate change mitigation; climate change; sustainable use and protection of water and marine resources; transition to a circular economy, waste prevention and recycling; pollution prevention and control; and protection of healthy ecosystems)

- Respect other objectives by avoiding to harm them significantly and to be informed about the technical screening for the notion of Doing No Significant Harm (DNSH)

- Be in line with the minimum social safeguards (i.e. the eight fundamental International Labour Organization (ILO) conventions).

These points are the architecture of the EC taxonomy[15] and provides guidelines to converge towards greener activities. The EC report of the published in March 2020[16] shed some light on interesting issues. The TEG was asked to elaborate on recommendations for technical screening criteria for the use by countries. The expert group has hence defined a flexible taxonomy regulation. The EC instructions were to consider only activities related to climate change mitigation or adaptation and to the DNSH's notion. The report currently provides a solid architecture for the economic agent to reorient their activities towards a more sustainable growth; nevertheless, the outstanding works of the EC are incomplete and may raise further issues up ahead. The taxonomy content is based on a questionnaire send to firms related to climate change; the survey, sent in September 2019, took into account 67 activities. Only 830 responses have been reported and "the vast majority of respondents were based in Europe, and 48% were private individuals, 24% were from the general business sector and 10% were from the financial business sector". (EC Report, March 2020, p.11). It is obvious that the coverage is not sufficient but it is an excellent starting point. Moreover, the survey is very oriented towards the climate change, which is not suitable since the climate change is the tree that hides the forest. Today the loss of biodiversity is also a great challenge for our societies. It is clear that a more global vision of the environmental damages is more appropriate. The final version of the European commission taxonomy will be available in 2022, however, in the meanwhile several changes appear; recently gas and nuclear sectors are considered as non-polluting since they do not increase the CO2 emissions level. This kind of orientation should reinforce the idea to enlarge the scope of the taxonomy.

## 2.3. The role of rating agencies in providing sustainable information

Since the 2000's, new types of rating agencies have rapidly developed. They have used criteria based on non-financial variables. They have also focused on the environmental, social and governance (ESG) field. Their evaluation criteria are not standardized due to the lack of an authoritative common taxonomy or definition. Nevertheless, they consider the international conventions, such as Standard

15 Based on the OECD works (2020), we propose a LU taxonomy framework in appendices.

16 https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy_en.pdf

Ethics, which echoes the recommendations of the UN, the OECD and the European Union. Unlike traditional rating agencies, investors, not issuers, pay for the ratings, potentially limiting the risk of conflicts of interest, although companies can still send these agencies for a Solicited Sustainability Rating (SSR). This is the case, for example, with Standard Ethics, a European agency based in London and Brussels[17]. Extra-financial ratings can be used for the Socially Responsible Investment (SRI) funds that incorporate extra-financial criteria into their investment choices before integrating companies into their portfolios.

Unlike traditional rating agencies, the largest non-financial rating agencies are in Europe. However, the most important of the financial rating agencies, Moody's and Standard and Poor's, have decided to enter in the sector, to capture their share in a growing market. Moody's has integrated ESG risks into its rating system and has developed a specific system focused on green bonds, while Standard and Poor's has acquired the UK's Trucost, which has specialized in environmental data, and has provided to investors more than 150 Dow Jones S-P indices that are built by integrating ESG criteria. Moreover, the change of agencies focus is not so recent. Indeed, at the end of 2017, the financial rating agencies realized that environmental, social and governance criteria have had a significant impact on environmental, social and governance criteria observed from June 2015 to June 2017. The conclusion of the survey is clear. In 225 cases, they even reasoned for a change of grade or perspective. Indisputable proof that the ESG criteria are taken into account in the credit rating of companies. ESG concerns are not new. However, there was a real trigger in 2015, with the launch of the UN Sustainable Development Goals (SDGs) and the adoption of the Paris Agreement. Today there is a lot of ESG indices or index families. Table-4- displays some sustainable indices. The list is not exhaustive but it illustrates the stocks index's diversity since years, however for the providers there are common points.

Few sample of ESG indices and their providers — Table - 4 –

| Providers | Index or Index family |
|---|---|
| Calvert | The Calvert Social Index |
| CRD Analytics | Global Sustainability Index, Cleantech 100, Life Sciences |
| Domini | Domini 400 Social Index |
| FTSE | FTSE4Good Index Series |
| EthiFinance | Gaïa Index |
| Maplecroft | Climate Innovation Indexes |
| MSCI | MSCI ESG Indices et Barclays MSCI (Fixed Income Indices) |
| oekom | Global Challenges Index |
| OWW | Responsibility Malaysia SRI Index, Responsibility Singapore SRI Index |
| RobecoSAM | DJSI |
| Sustainalytics | Jantzi Social Index, STOXX Global ESG Leaders Indices |

17 http://www.standardethics.eu/

| | |
|---|---|
| Vigeo | ASPI Eurozone, Ethibel Sustainability Index, Euronext Vigeo |
| Thomson Reuters | Thomson Reuters Index |

Source: Novethic Report, 2014[18], p. 8

Commercial providers are private organizations; the quality of the databases may be questionable since among the private providers, the information is not always transparent. Remind that some entities are classified ESG by some private providers and not ESG by NOG or public rating agencies. More precisely, with the IPCC classification, the Toyota Motor Corporation is listed as a high carbon emissions firm whereas the MSCI ESG Ratings classify the same firm as a low emission company (Choi et al., 2020). These divergences should be avoided at the very short term because they are not consistent. Moreover, they raise again the question of the reliability of private/commercial data providers, which are largely used by academic papers and the central bank's researchers and/or analysts.

Likewise, many Funds certification agencies have appeared in the financial landscape. Amongst them, we can cite Luxflag (Environment and climate change). This Luxembourg non-governmental organisation created in 2014 provides labels based on ESG criteria to classify funds[19]. Other European label entities have played the same role (FibelFin QS for Belgium; FNG-Siegel for Germany; label ISR and Label Green fin for France). Nevertheless, when we compare the methodologies and the thresholds associated with each of the variables, there are slight differences. This means that some funds may be qualified sustainable by some entities and rejected by others (Novethic Report 2019[20], p. 3). In line with the same report, there are also great disparities amongst the types of labels, the targeted variables, the variables' thresholds, and the annual costs (Novethic Report 2019, p. 4 and p.6).

IPPC reports have also noticed that notwithstanding the public awareness there is no drastic reduction of CO2 emissions for instance. This means that the environmental actions are not providing sufficiently strong signals to encourage financial institutions to provide the capital required to achieve their sustainability targets.

As stated in the previous paragraphs several commercial private commercial providers have built indicators assumed to assess the size of the ESG product, this means that the private sector is very dynamic to collect and provide ESG database. Several analysis and research institutes have used their expertise for their empirical works. Indeed, the Joint Research Centre (JCR) published several empirical papers using such databases provided by Bloomberg, for instance. Based on commercial database from Bloomberg, Alessi et al. (2019) have demonstrated that there is a negative green risk premium for the European stock returns and portfolios by using the Bloomberg ESG scores. Authors also resort the database by excluding some firms clearly not sustainable (i.e. HSBC or Allianz), which prove how the private database can be questionable and therefore suggest to not give a public statistics collection mission to private providers. The unique indicator taking into account by the authors is the Bloomberg indicator that might not be enough to capture the firm's sustainability, in particular with respect to

18 https://www.novethic.fr/fileadmin/user_upload/tx_ausynovethicetudes/pdf_complets/2014_Panorama-des-agences-de-notation.pdf

19 https://www.luxflag.org/media/pdf/criteria_procedures/LuxFLAG_ESG_Label_Eligibility_Criteria_June2016.pdf

20 https://www.novethic.fr/fileadmin/user_upload/tx_ausynovethicetudes/pdf_complets/Novethic-Panorama_des_labels_europeens_de_finance_durable-2019.pdf

environmental criteria. This choice has raised the question of the results robustness since the estimations are fully determined by the choice of the ESG indicators; to overcome these bias, authors should use several indices and compare the estimation results stability. It is useless to strengthen that there is an important development of diverse and provisory thresholds criteria to classify financial assets, so it is quite difficult to get definitive and undisputable conclusions given the evolving change in the concepts. The complexity of this diversity has reinforced the idea of the harmonization of related environmental data to ensure comparisons between countries. The rapid explosion of standards and labels compel public statistics authorities to attempt to define in a timely manner reliable sustainable concepts that are the cornerstone of the climate change transition.

Thus, the main limitation is the lacks of harmonization, of reliability and of common guidelines that can be harmful for the countries. One of the most relevant example is the CO2 emissions prices. Indeed, until now, there is no universal price for the CO2 price despite the environment urgency. According to the World Bank (WB) website[21], not all countries determinate the CO2 emissions prices. The WB has published a carbon prices dashboard, which demonstrates that carbon prices vary across countries since different carbon pricing methods exist. There are therefore disparities amongst countries. Moreover, not all countries apply a carbon price. This situation may create a free rider behaviour. If we do not resolve this tricky question, it is not possible to provide efficiently a fair carbon tax. Moreover, it is useless to remind that some firms do not report the scope 3 of their CO2 emissions, which the share reported to the total is significant since for a large company the scope 3 represents more than 80%.[22] Another issue related to fairness may also emerge with the current common CO2 taxes. It can be resolved only if there are reliable granular information about the CO2 emissions per firms. At term and with the development of artificial intelligence (AI), it may be interesting to compel all firms to report their CO2 emissions and implement taxes according to their levels of pollution. Moreover, despite numerous carbon disclosure initiatives, there is no harmonized metrics to measure the carbon footprints (Zimmerman et al., 2020).

To resume, the necessity of harmonizing ESG criteria, definitions, and classifications[23]is crucial and exposed by several European reports (STC CCS Report, 2019; CMFB TF Sufir, 2021, Green Swan reports, 2020, 2021). These divergences should be avoided at the very short term because they are not consistent. Moreover, they raise again the question of the reliability of private/commercial data providers, which are largely used by academic papers (Peillex and Ureche-Rangau, 2016; Alessi et al., 2019; Brière et al., 2020). This point is paramount for the public provider's challenges because public statistics authorities are supposed more reliable given their transparency, integrity, and objectivity characteristics. In addition, it may be interesting to underline that the current European "Green bonds" time series are based on Bloomberg information[24] and we should not neglect the agency theory problem related to the asymmetrical information because of the "principal-agent" relationship where a Financial Regulator risks to be "captured". Central banks or regulation authorities should participate actively to the disclosures of reliable granular database related to ESG problematics. Remind that the role of the central bank is paramount to tackle the tragedy horizon in promoting green finance thanks to monetary and prudential tools but before they have to participate actively to define the green perimeter and collect reliable data to guarantee policy efficiency.

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21 https://carbonpricingdashboard.worldbank.org/map_data

22 https://secrhub.co.uk/scope-3-emissions-your-frequently-asked-questions/

23 For instance, the identification of the low/high carbon firms is still puzzling that is not normal given the climate change emergency. Indeed, according to the Intergovernmental Panel on Climate Change (IPCC) report published in 2019, there are 5 major industry sectors assumed to be highly polluting. However, the classification built by MSCI ESG Ratings, which scrutinize companies' environmental, social, and governance issues, provide contradictory results.

24 NGFS Dashboard, pp.18-22 (Source: https://www.ngfs.net/sites/default/files/medias/documents/dashboard-on-scaling-up-green-finance-march_2021.pdf). This database is briefly presented in the next section.

The major needs are to develop common, harmonized and reliable databases and definitions to ameliorate the works of users and especially of the central bankers to evaluate the impacts of climate change on the financial stability, for instance (Bolton et al., 2020; Green Swan, 2021[25]).

The next section is dedicated to describe the current the existing data gap in Europe and how the central banks as users and as potential producers, have to deal with this problem.

# 3. Sustainable databases needs and the role of central banks: Some European experiences

The aim of this sub-section is to discuss why the central banks should participate actively to green economies. To reach this target, they need reliable databases to run sustainable and efficient policies. Remind that since centuries, the central banks have to adapt themselves to the economic context and they have innovated in terms of regulation and supervision tools to avoid dramatic crisis repercussions and particularly systemic crisis. Since 2008, the use of conventional and unconventional tools is frequent (Ugolini, 2017, Goldman and Zhang, 2021). In addition, during the sanitary crisis in 2020, the role of central banks has been significant to save the economies; the ECB has not hesitated to set up non-conventional policies and adopt the strategy based on the famous "whatever it takes" (Mario Draghi, 2012)[26].

## 3.1. Why do central banks need sustainable database?

In this section, we argue the role of the central banks is to ensure the ecological transition; why central banks should be active in the fight against the climate change and how the database should be necessary to ameliorate our knowledge on this topic. We do not need only more database but also qualitative database, the quality is the cornerstone of any serious studies. It is well established now that the climate change has impacts on the stability prices and the financial stability, therefore central banks are athe center of the climate change debates[27].

Different tools are under discussions to "green the financial system". From a (micro and macro) prudential views, they concern variables such as liquidity, capital, reserves and lending thresholds. Crockett (2000) and Borio (2003, 2006) have provided an accurate distinction between the macro and micro-prudential approaches. The macro-prudential tools have been largely proposed by political literature (Borio, 2003, 2006); and have been incorporated in the Basel (I, II, III) requirements. From a monetary optic, we analyze the current debate on the role of interest rate in greening the financial system. We also extend the discussion to others CBs' prudential actions, from the conventional interventions to non-conventional policies, namely the quantitative easing.

Table-5- displays the most implemented monetary and prudential policies tools under debates to support the financial system. These policies are famous and frequently set up by CBs.

[25] https://www.bis.org/events/green_swan_2021/overview.htm
[26] https://www.politico.eu/article/ecb-will-do-whatever-it-takes-to-save-the-euro/
[27] https://www.ecb.europa.eu/ecb/climate/html/index.en.html

Main Monetary and prudential tools Table-5-

| Policy | Tools | Conventional(C)/or Not (NC) | Targets |
|---|---|---|---|
| Monetary | Interest rate<br>Lending control<br>Reserves | C/NC (for negative interest rate) | "Without prejudice to the objective of price stability", the Eurosystem shall also "support the general economic policies in the Union with a view to contributing to the achievement of the objectives of the Union". These include inter alia "full employment" and "balanced economic growth". [28] |
| Macro-prudential | Capital<br>Liquidity<br>Lending control | C | Short-term target: Avoid or limit the global financial system distress.<br>Long term target: Avoid GDP losses |
| Micro-prudential | Regulatory standards of financial services | C | Short-term target: Avoid or limit turbulence of individual institutions.<br>Long term target: Consumer protection |
| Quantitative Easing | Large-scale asset purchases of long-maturity government debt and private assets. | NC | To lower long-term interest rates and consequently boost the economic growth. |

Source: Author

A rapid glance at Table -5- shows that these tools could be used to re-orientate the traditional finance system towards the socially responsible finance without huge efforts. The goal of the following paragraphs is to visualize how CBs may contribute to swift from a traditional financial system to another in accordance with the 1,5 degree elevation trial as explored by the Paris Agreement. Remind that climate problematic matters are a component of the environmental distress.

As witnessed the central banks history, their new missions have occurred to save the financial and economic systems (Goldman and Zhang, 2021). Today, the climate change has created risks and uncertainty. Uncertainty always creates instability and particularly financial instability (Minsky, 1998). In accordance with Jeffers and Plihon (2019), climate risks may lead to a systemic risk and this would transform the economic and financial mechanisms of our society (a "Minsky moment").

Additionally, few CBs have introduced the nature preservation in their missions. Indeed, Dikau and Volz (2018) set out different areas of actions for the CB, based on micro and macro prudential regulations to sustain the ecological finance. They highlight micro prudential policies disclosure requirements, the adoption of a standard framework for risk assessment, the environment etc. At the macro-prudential level, climate-related stress tests, capital buffers, for example, are proposed. All of these instruments are popular because they have been using for decades. However, the central banks have yet to define the environmental framework in an accurate and harmonized manner. Dikau and Volz (2018) have also analyzed 133 central banks and underlined that only 12% of central banks explicitly state in their

28 https://www.ecb.europa.eu/mopo/intro/objective/html/index.en.html

missions the support for socially responsible activities ("sustainable economic growth / sustainable growth/ sustainable contribution to economic growth/ sustainable growth of the economy/ balanced and sustainable economic development/achieve and sustainable growth"). This means that many banks will have to redefine their legal framework to implement sustainable policies in the near time. This may be not a complete overhaul of their missions but likely simply an extension to responsible activities.

We start the development of sustainable tools with the interest rate tool presentation. Plenty of theoretical and empirical articles have attempted to explore how the interest rate should be able to orientate optimally financial flows towards sustainable sectors (Kempf, 2017; Muller, 2019). It make sense to define clearly an ecological interest rate since climate change has negative impacts on natural interest rate and economic growth. This adjustment variable should take into account externalities that green gas emissions have produced since decades, for instance. The rates should be very low when the project is sustainable and higher in case of brown projects. The sustainable interest rate is a very interesting topic in a normal context. However, it is not sure that its implementation is feasible within the low (even negative) interest rate framework. Indeed, this pro-climate policy is not suitable in the case of unconventional monetary policy (negative rates) since, more often than not; a CB uses it because the interest rate instrument is no more efficient, since the interest rate has reached its lowest threshold. However, this point is questionable. Some papers have attempted to demonstrate that during a long period of low interest rate (even negative) the QE tools have failed to "feed" the economic growth because of headwinds and the non-linearity interest rate effects. When the interest rate is close to its effective lower bound (ELB), it may have costly effects on the financial stability (Borio and Hofmann, 2017; Borio and Zabai, 2018). Within a Bayesian Structural Vector Auto-Regression (SVAR) framework, Lhuissier et al. (2020) have found that in a specific case, the easy money has a positive impact on growth even during the period of very low interest rate (close to 0). This result should also be balanced with a negative rate.

Globally, the macro-prudential tools are based on reserves, capital, credits control and liquidity. For this latter, several tools are defined in the Basel III requirements: the Liquidity Coverage Ratio (LCR) and the Net Stable Funding Ratio (NSFR). The LCR is assumed to provide information about the short-term liquidity whereas the NSFR takes into account the long-term perspectives. These two ratios should be modified to develop sustainable activities since as they are calculated they penalize long-term projects and privilege the short-term investments. The socially responsible activities need long-term investments and lower liquidity ratios are welcomed (European Banking Federation, 2018). For the credit, it should be suitable to give the priority of sustainable projects. A credit classification related to ceilings according priorities should be built (Fry, 1995; Volz, 2017). Support for environmental credits at the expense of brown credits should be a recommendation (or better still an obligation) to financial institutions (Fry, 1995; et al., 2015; Schoenmaker and Van Tilberg, 2016). The capital requirement (CR) should also be revisited according the sustainable activities since the CR encourages brown activities given their short-term horizons. The risk weighted assets necessary to calculate the CR should introduce the climate risks for instance. Furthermore, differentiated reserve requirements in favor of banks that finance sustainable projects should be established (Volz, 2017; Jeffers and Plihon, 2019, 2020).

All these tools may be useful to promote sustainable growth if they are well calibrated[29]. However, we need more analytical studies based on reliable data to evaluate correctly the impacts of green tools on economic growth and financial stabilities.

[29] Artificial intelligence (AI) may help to provide a better calibration; however, AI is energy consuming leading to an increase in CO2 emissions in a climate change emergency context.

For the micro-prudential optic, according to Dikau et Volz (2018) the regulators should offer regulation standards oriented towards sustainable activities, provide strict disclosures rules and define a clear legal framework to protect the consumers (depositors and investors).

Regarding the unconventional monetary policy, namely the Quantitative easing, it may be interesting to launch European Green purchase program to promote sustainable sectors and limit or stop financing brown activities. In the debate on greening the financial system (see the NGFS work) and promoting climate-related financial disclosure (see the TCFD work), there is a growing attention on the Quantitative Easing by zooming on Corporate Sector Purchase Program (CSPP). Diverse papers have sought to track the purchase and identify the sectors supported by the CSPP and found they create distortions in favour of carbon intensive sectors (Schoenmaker, 2019). In addition, the outstanding works of Battiston and Monasterolo (2019) based on 1557 securities issued by 282 firms have concluded that more than 60% purchased equities have financed brown firms (production and distribution of fossil energies, automobile sectors, electricity production). Their analysis has also found that Bundesbank and Banca d'Italia are exposed to automotive and fossil firms.

Besides, there is a gap between the climate change and the capital aligned with climate change goals. The main cause of this misalignment, which represents a systemic risk, is a lack of harmonized definition/taxonomy and a kind of lethargy because of the long-term horizon. The famous adage "we have time" is likely responsible of the lacks of actions. Furthermore, most of EC's works expose guidelines, proposals and recommendations. There is no coercive measures. Besides, the different surveys (BIS[30], ECB[31]) on the data availability have demonstrated that there are lacks of quality, of harmonization/standardization, of coverage etc.

In addition, to evaluate the impacts of green/sustainable policies mentioned above, we also need to have an accurate idea of the physical and transition risks since currently the central banks' user needs on climate related aspects are priorities. Once we define and measure correctly the climate change risks, they can serve as warning indicators to activate or prudential tools and provide information on exposure on financial institution though their asset portfolios (even the real estate assets), on the carbon footprint of the asset portfolios, the development of sustainable financial instruments issued (bonds or loans, for instance) at both aggregated and granular levels. The calculations of physical, transition and liability risks probabilities become the next step once we get qualitative database[32].

These risks are multifactorial both scientific and economic then it means a perfect collaboration between economists and scientists; and in a global manner, climate change is matter of all researchers whatever their fields (economics, mathematics, physics, biology, health etc.)

## 3.2. Databases available for users and their main common limits: Some relevant examples

As briefly evoked in the previous developments, there is an arsenal of data related to the environment concerns that could be used to analyze the impact of the climate change on the financial stability guaranteed by the regulation authorities such as central banks, but the quality is questionable (Section 3.1). Moreover, the length of the time series are not always significant and we record several non-available observations for some variables and/or indicators. This subsection aims at describing the

30 https://www.bis.org/bcbs/publ/d502.htm and https://unece.org/sites/default/files/2021-03/S4_5_CC_and_financial_Fortanier.pdf

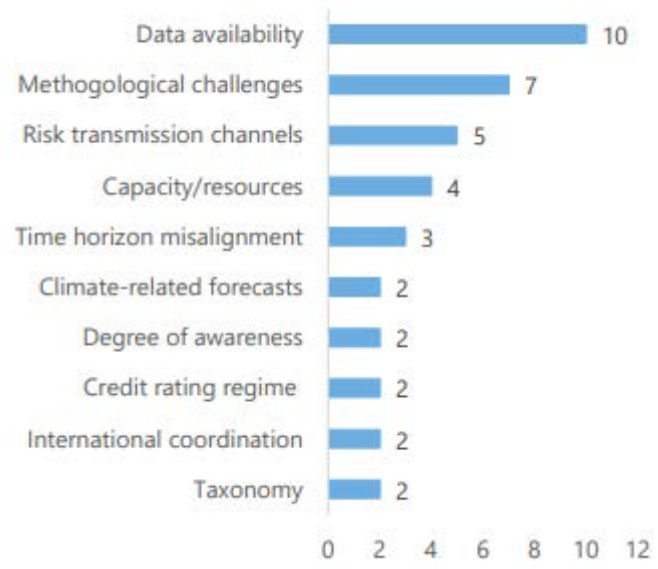
31 EG STC CCS

32 See Annexes Figure. A.1. A simplified example of the tool's activation.

availability of some sources providing data, which permit to measure the physical and transition risks. These risks are fundamental to study any environmental potential crisis. Many sustainability information are available and it is not the goal to cite them all. However based on surveys and a sample of examples, it is largely demonstrated that currently the database have some limitations in terms of availability, harmonization, standardization, low coverage, data inconsistency, common identifiers etc.

In this subsection, we describe briefly two main surveys launched by the EG STC CCS and the BIS in recent periods. The BIS Survey was launched in 2020 by the high-level Task Force on Climate-related Financial Risks (TFCR) to provide information on the sustainability concerns from several jurisdictions[33]. The questionnaire is composed by 8 questions related to the climate change risks. Unsurprising, the survey reveals that the lack of data is the main central banks concerns followed by methodological challenges and the risk transmission channels, however, surprisingly, the necessity to set up a reliable and commonly accepted taxonomy is at the bottom of the concerns while the taxonomy is the cornerstone of the sustainability (Chart-1-).

Challenges identified by number of jurisdictions Chart-1-




Source: Basel Committee

The EG STC CCS questionnaire relative to climate change studies has been sent to all the members of the STC, the national and central banks and EIOPA in 2020 to collect information about analysis of the climate change undergone by the central banks, for instance. The main results of this survey is that amongst 81 studies, there are 53 published studies and 28 ongoing works, meaning that central banks are highly involved in the ESG issues. A more detailed survey analysis has shown that 1/ works deal with mainly with the financial sector (40%) followed by the non-financial company (15%); 2/ most of works

[33] List of participating Basel Committee members and observers: Argentina, Australia, Belgium, Brazil, Canada, China, European Banking Authority, European Central Bank, European central Bank, France, Germany, Hong Kong, Indonesia, Italy, Japan, Korea, Malaysia, Mexico, Netherlands, Russia, Saudi Arabia, Singapore, Spain, Sweden, Switzerland, United Arab Emirates, United Kingdom, United States.

are oriented towards transition risks (63%) followed by transition and physical risks (22%) and by physical risks (10%). These research/analysis trends reveal that central banks have already defined their priority, namely the study of transition risks.

Moreover, the main common conclusion deduced from the both surveys is the priorities orientation towards reliable databases relative to physical and transition risks, meaning that data in this field should be rapidly produced in a qualitative manner and spread to all users. Then, variables assumed to participate to the physical and transition risks formalization should be a data collection priority.

The transition risks variables, particularly the CO2 emission are on the top of the priority for several reasons. The first one is the CO2 emissions is the principal cause of the global warming, the second reason is more related to climate change metrics since this variable is the cornerstone of the CO2 taxation that is a puzzling issue today. However, it is not possible to fight against the global warming without having an accurate and reliable measure of the CO2 emissions. The next paragraphs are dedicated to three variables, oriented towards pollution problematics, aiming at measuring of CO2 emissions that are crucial for the development of supervisory tools, stress tests, anti-green washing instruments etc.

The European Pollutant Release and Transfer Register (E-PRTR)[34] is a source of database contributing to increase the data offers for users, however some improvements are required for an optimal utilization.

The register furnishes annual data since 2007 based on more than 30,000 industrial facilities covering 65 economic activities. The environmental data take into account the amounts of pollutant releases to air, water and land as well as off-site transfers of waste and of pollutants in waste water from a list of 91 key pollutants. For air pollution, the dataset includes greenhouse gases (carbon dioxide, nitrous oxide or methane etc.). Other gases are also delivered as well as different sorts of heavy metals or pesticides, that are also crucial categories for the consideration of pollutant releases to water and land.

The first reason of creating the register was for the purpose of environmental policies, thus not for statistical purposes; hence, it does not include relevant information, which could facilitate its use for statistical goals. For illustration, there is no ID (identification) such as LEI (Legal Entity Identifier) for the parent companies of the facilities or any relevant Nomenclature of Economic Activities (NACE)[35] code. This limit should be treated in a very short term to improve the supervision and the quality of the data. Remind that the lack of quality is an important wheel for the use of the database. Moreover, the coverage scope and the harmonization are not enough, which represent actually a weakness.

For the CO2 emissions related to the transaction risks, it may be interesting to take into account the database related to the EU ETS[36] (European Emissions Trading System). The EU ETS is based on a cap and trade system and it allows emissions allowances exchanges. This is the major instrument to meet the Paris agreement targets, and to fight against the climate change and its negative damages on earth and on economic systems. This tool takes into account around 11 000 power stations and industrial plants in 31countries including airports flights. The benefices of the cap-trade system is undeniable (controlled quantity, flexibility and efficient cost-benefices system). Several fields in economy and finance could use this information to complete and improve the works studying the role of the climate change policy to tackle the horizon tragedy. However, as already mentioned earlier, ETS tool has some limitations. Indeed, the scope is still limited; a NACE classification is welcome since the most important pollutant sectors are building and transport according to IPPC report published in 2019; there is a lack

[34] Regulation (EC) No 166/2006. E-PRTR replaces the former European Pollutant Emission Register (EPER).
[35] https://stats.oecd.org/glossary/detail.asp?ID=1713
[36] https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf

of standardization; few entities have a ID (ex. LEI) that increase the monitoring difficulty etc. These limits also constitute the future challenges of the statistics authorities to meet the needs of the users and especially those of central bankers.

In a general manner, there are several data that are not consistent given the lack of quality control; as already underlined the quality of the commercial data is not optimal and most of analysts/researchers use them to write their articles or reports and few of them precise these fundamental limitations.

All these limitations should be the next challenges agenda for any authorities engaged in the understating of the sustainability problematics and aiming at promoting green finance and defining regulation policies.

## 3.3. Some specific initiatives from central banks: the sustainable bonds database for Luxembourg

The first green bond was launched by the World Bank in 2007. Soon thereafter, in 2008, the European Investment Bank (BEI) launched the first European Green bond that has been listed on the Luxembourg Stock Exchange and that is considered a reference product in this new category of financial instruments.

Although, the functioning of Green bonds is very close to that of traditional bonds, their main characteristics differ since the underlying assets have to match the ESG criteria. Since the initial launch in 2008 by the EIB, the green bonds market has skyrocketed in Europe. Indeed, over the years, green bonds have become a key tool for greening finance as well as all other economic sectors. The Green Bond Principal (GBP) from the International Capital Market Association (ICMA) has established a standard procedure allowing issuers to raise capital in order to increase the environmental benefits thanks to an administrative guidance (GBP DIWG, 2017). In 2016, "Luxembourg Launches World's First Green Stock Exchange: LGX" (Medland, 2016).

Over the years and particularly in 2015, there has been an acceleration of the green finance development. This trend is related to several multi-dimensional factors. One of the most important factor is the growing awareness of the need to reduce the CO2 emissions and to protect the planet. The Agreement of Paris in 2015 has been a corner stone for several policy propositions to tackle the climate crisis. The European green bonds evolution has demonstrated that Green bonds have skyrocketed and this trend reinforces the idea that the sustainability concerns are nowadays more concrete, even if there is no consensus on the definition. However, the financial literature provides some relevant conclusions on the drivers and the transmissions channels for the sustainable bonds.

The database[37] is built thanks to several sources. All ESG criteria are taken into account to avoid the scope limitation. We are interesting in the debt securities issued by ESG companies. To detect these firms we rely mostly on the classification of the Green Luxembourg Exchange, which is a reliable provider (137 issuers). To complete this data source, we compare with other sources such as ECB (21119 issuers) Refinitiv, formerly Thomson Reuters (2 448) and Euronext (384 issuers). All International Securities Identification Number (ISIN) codes[38] have been cross-checked with the Centralised Securities Database

[37] A. Carreira and S.Gueddoudj (2021). "Sustainability bonds and their main features in Luxembourg from 2013 to 2021: An experimental approach. Forthcoming.

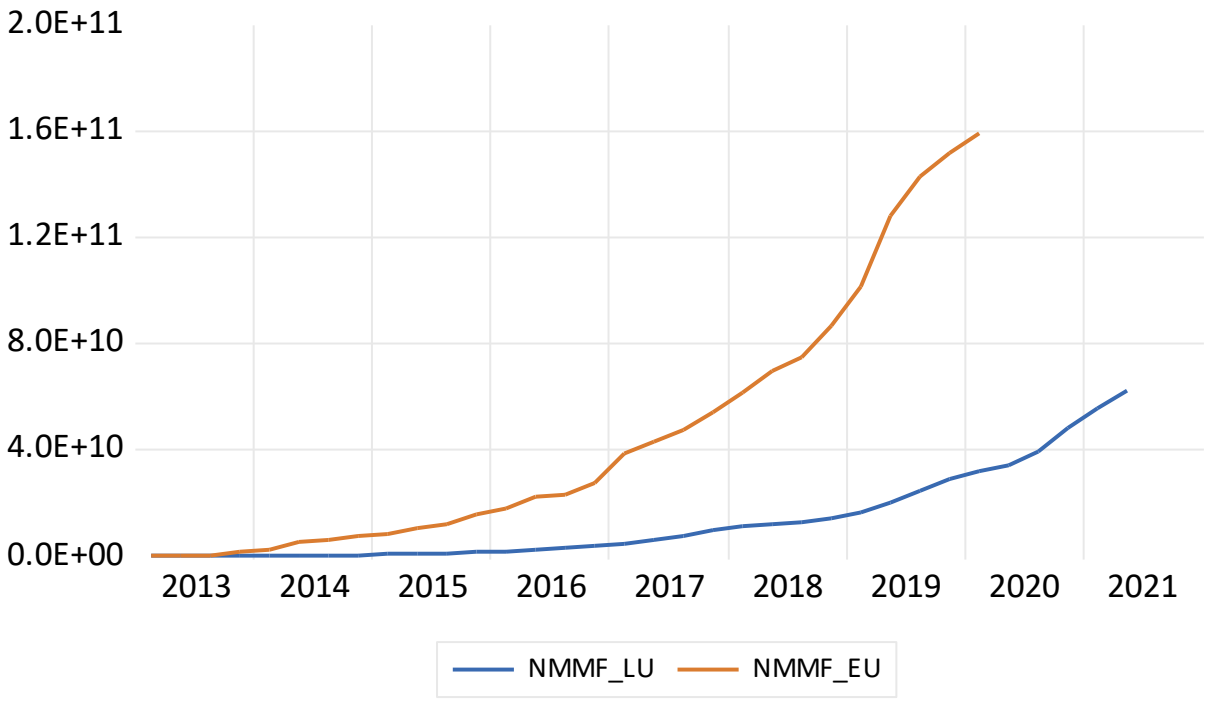
[38] https://www.isin.org/isin/

(CSDB)[39]. Only the Luxembourgish holders are taken into consideration to start, we are aware that it is a limited scope and we will be compelled to enlarge it sooner or later; however it is a good starting point to explore and therefore have an acute idea of the feasibility and the main obstacles to overcome for larger scopes. There is no limitation for the size of the sample since we only consider the ISIN code that is not the case for some other European initiatives that consider only large size (>5 bln EUR). We reject this approach to avoid a size bias. We have tried to limit the overuse of the commercial providers such as Bloomberg given their informational opacity and their questionable classification; however we have decided based on the ISIN code to verify if the share appears in other databases. Moreover we have taken into consideration a strict definition of green finance, since we include entities with only sustainable projects (narrow definition) and exclude those managing both sustainable and non-sustainable projects (large definition). Finally, we recover 3 075 unique ISIN codes for the 2013-2021 period.

The provisory database for Luxembourg provides interesting results in line with the European Green Bonds database published by the ECB. The following graph displays the time series trajectories of the sustainable bonds.

Chart -2-

European (EU) and Luxembourg (LU) Sustainable bond holders time series (Quarterly frequency, Stocks, from 2013Q1 to 2021Q1, billion Euro)




Sources: BCL and ECB

[39] The CSDB is a database fed by several commercial data providers and institutional sources, including ESCB national central banks and the ECB.
https://www.ecb.europa.eu/pub/pdf/other/centralisedsecuritiesdatabase201002en.pdf

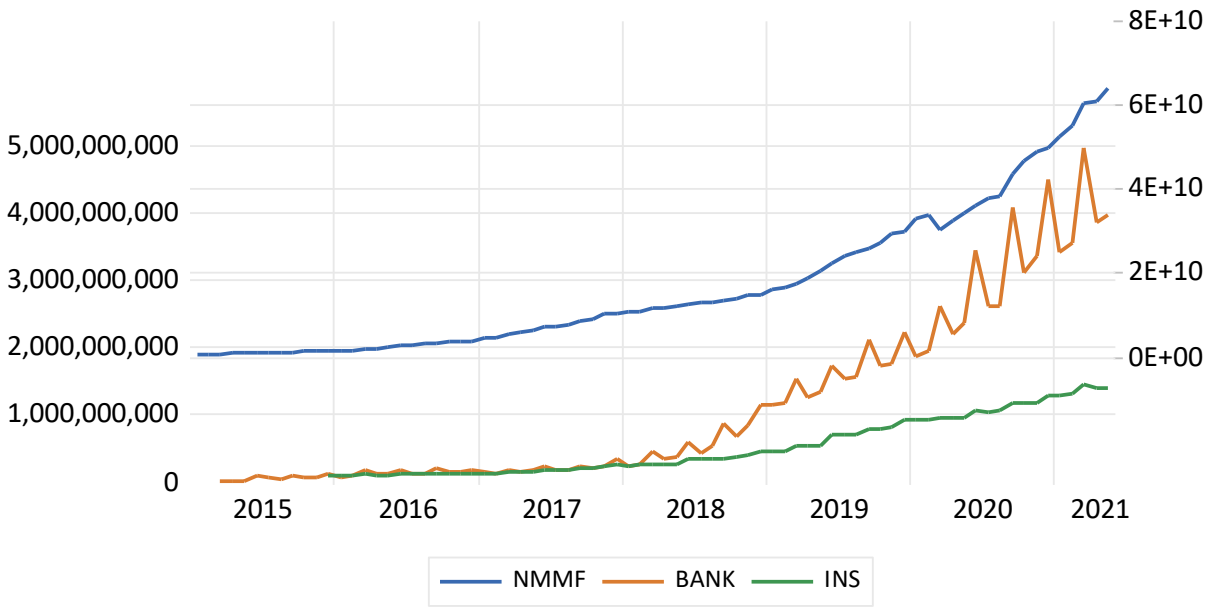
Both curves have an increasing trend, which confirms the development of sustainability concerns amongst the investors. They are now more sensitive to the ESG criteria for their investments that is satisfying. The sustainable bond stocks for Luxembourg and Europe for the period 2016Q1 to 2020Q1[40] had respectively been multiplied by about 16 and 9.

Given the time series trajectories, the regulators should promote the information disclosure and this information should be transparent, harmonized and verifiable. This is the most important challenge for the regulation authorities because the Green Bond Principles (GBP) are voluntary guidelines set out by the International Capital Markets Association (ICMA), first introduced in June 2018 to provide transparent accurate and honest information to investors. Two remarks deserved to be highlighted. First, there is no mandatory and until now the sustainability criterial are not harmonized and there is no consensual definition. Secondly, it is very important to have an accurate picture of the sustainable bonds evolution for regulation purposes.

By laying aside these remarks for a while, it is also interesting to note that there are some similitudes between the European bonds and the Luxembourg bonds. From the holders' side, according to the ECB database, the main holders are non-monetary market funds followed by the insurance and bank sectors. For Luxembourg, the ranking is quite similar since the holders are mainly from the non-money market funds (NMMF)[41], banks (BANK) and insurances (INS). For each sector, there is an amazing development as witnessed by the chart hereafter.

Chart -3 -

Time series trajectories for different holders sectors (Monthly frequency, from 2015M01 to 2021M05, Stocks, billion Euro)




Source: BCL

[40] We have chosen this period because there is for both bonds curves a take-off.
[41] https://www.ecb.europa.eu/pub/pdf/other/eb201604_article01.en.pdf

The banking sector, followed by the insurance sector, is an important holder of bonds regardless of the bond category. This ranking is not surprising since money non-market bonds (NMMF) in the ESG field are still important actors in the economic funding in Luxembourg. Moreover, banks (BANK) are heavily interconnected with other financial institutions such as money market funds. This interlinkage is not new and has been largely described by the financial literature (Jeffers and Baicu, 2013; Sengupta and Xue, 2020), whose the most common conclusion is that the development of non-banking activities is related to three principal factors, namely the regulation policy, the surge of fintech start ups and banking competition. Moreover, COVID-19 accelerates the development of non banking and fintech activities in all areas. This tendancy is not an ephemere change but a protracted transformation. The economic funding is essentially oriented towards markets, which is not a bad thing if they are monitored by legal authorities. However, sometimes financial services are sophisticated, not regulated and higly risky. The main limits of this kind of services are the dearth of tranparency and liquidity and they often escape from all surveillance and regulation processes. Indeed, some bond assets are funded by non-banking saving instruments. Consequently, there are tight linkages between the bond market and non-banking activity (Gabor and Ban, 2015; Ehlers and Zhu, 2018). In addition, according to the Financial Stability Board, the non-banking may take two principal forms that are securitization and the development of the high-yield bond market.

This point has raised the questions of financial stability and of stress testing, for instance. Indeed, the main threat is the non-money market funds'risk-taking decision trade-off between the benefits of the financial products inflows and the risk of causing negative spillovers to other parts of fund sponsors'business. This potential threat could occur in case of financial disruption because of the incertainty related to the recovery expectations and the sanitary crisis.

The building of green bonds database is therefore essential within the framework of stress tests, for instance. Indeed, they permit to test how the system is resilient to extreme events. These kinds of tools have been used by central banks after crisis to furnish essential information on the resilience of the financial and monetary system (bank, market, insurance). The evaluation of the system's resilience is fundamental for the regulation authorities since the systemic risk is omnipresent and its consequences on economies are dramatic. Stress tests require qualitative database and this stage it is currently impossible to implement them in an optimal manner.

By using this databases in a bivariate Midas-VAR model (GDP, Sustainable bonds), we find that the Green bonds impacts the GDP (Carreira and Gueddoudj, 2021). The relationship is long term and bidirectional (VAR Granger Causality/Block Exogeneity Wald Tests). This result has emphasized the interlinkage between the real sphere (GDP) and the financial sphere (sustainable bonds) and therefore the occurrence of a systemic crisis in case of endogenous or exogenous shocks. Even if the results are consistent (since several robustness test have been run) and encouraging, unfortunately the length of the database is too short (about 36 observations)[42]. The provisory solution linked to the length problem is to develop models dedicated to short database since the algorithm aiming at increasing the length introduces biases.

As already underlined previously, there are several initiatives to fill the gap in terms of data, and more particularly in the green bonds fields and these initiatives are welcome and the efforts should be pursued since despite all these efforts, the data gap is still paramount. Nevertheless, to tackle the data gap challenge several recommendations are required.

[42] We should note the definitions of large sample (>30 or >50) and small sample are still under debates.

# 4. Recommendations for CB database users

One of the most important challenges is to deal with the database public availability and their disclosures. The production of qualitative database concerns diverse levels (sector, geographic, granular and aggregated). Several reports from European and international institutions (BIS, ECB, IMF, NGFS, World Bank, etc.) claim more qualitative database whatever the costs since there is no issue without reliable and harmonized data. Our future is shaped by the development of database since data are the engine of our empirical models assumed to orient the policy strategies of today and tomorrow. The aim of this last section is to provide some exploratory recommendations related to the data user's challenges. These latter are related to the methodologies and the tools to reduce the data gap and upgrade the disclosures and the content. The next steps should be a rational, orderly and international cooperation. This section is a kind of specific conclusion (based on the previous developed paragraphs) exposing how the central banks as data users and producers may act for the improving of the climate change approach. Three points are explored: bottom-up and up-down methodologies for a better regulation, the store tools (dashboard, catalogue or in a global manner repository) and general provisory recommendations.

## 4.1. Needs of sustainable data for a better regulation: Bottom-up and top-down approaches

This sub-section is dedicated to regulation methodologies and recommendations for the short term perspectives to achieve an optimal sustainable transition. As admitted, today the data gap challenge is the most important challenges for central banks during the short term and the cornerstone of many sustainable issues.

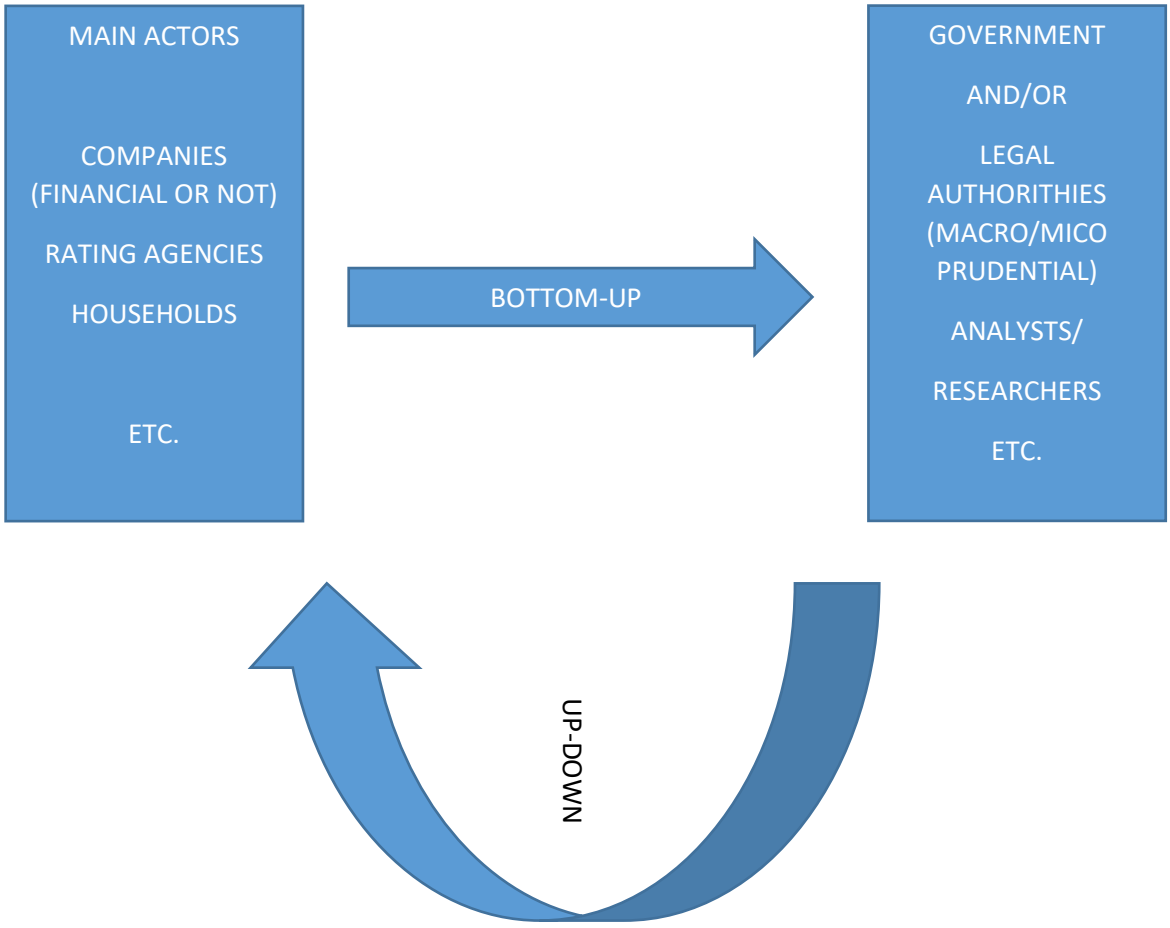
Regulation is a corollary of any monetary and financial policies to reduce risk of significant costs to taxpayers and the financial system (i.e. limit the systemic risk). It also provides benefits to reach sustainable goals. The regulation tools require qualitative database and harmonized concepts to reach their goals. There are several sustainable information flows but they suffer from a lack of quality, therefore (bottom-up/top-down) approaches seems to be a good alternative to ameliorate the data gap and the regulation tools.

There are several methodologies and the aim of this section is not to describe all of them but the most common used or proposed by the principal actors of the climate change. As already known, the most used methods are the bottom-up and the top-down (or need to do) methodologies that have been largely described by the literature (Sabatier, 1986; Yohannes, 2001; Suntharasaj, 2013; Ljungström et al. 2020).

Regarding the top-down methodology, we start by defining and modelling the top level concepts that are refined during the process and this kind of approach is most of the time run by highly qualified experts in the domain such as engineers, for instance. Whereas the bottom-up approach is close to a macro vision since it starts from assumption already defined the scope framework through concepts and architecture, as well as the technical terminologies and the conceptual knowledge used for the architecture building. Of course both methods are useful however, they have advantages and drawbacks. For the top-down approach, it is a friendly method, reused and multi-usage .Therefore it is possible to define new research path for instance. Moreover, the flexibility of the methodology of a cost

such as the degree of expertise, the cost, the time consuming and the important effort to run this king of approach. Given all these limits, it is obvious that sooner or later, the size will be a constraint and it depends on the current knowledge including legal one that is highly evolving and dynamic. For the bottom-up approach, there are several advantages such as the larger scale and more rapid since all the scope and the technical framework is already defined and relatively difficult to change in case of rapid evolution and may be costly. Figure-1- represents the interlinkage between both methodologies.

Bottom-up and up-down scheme Figure-2-



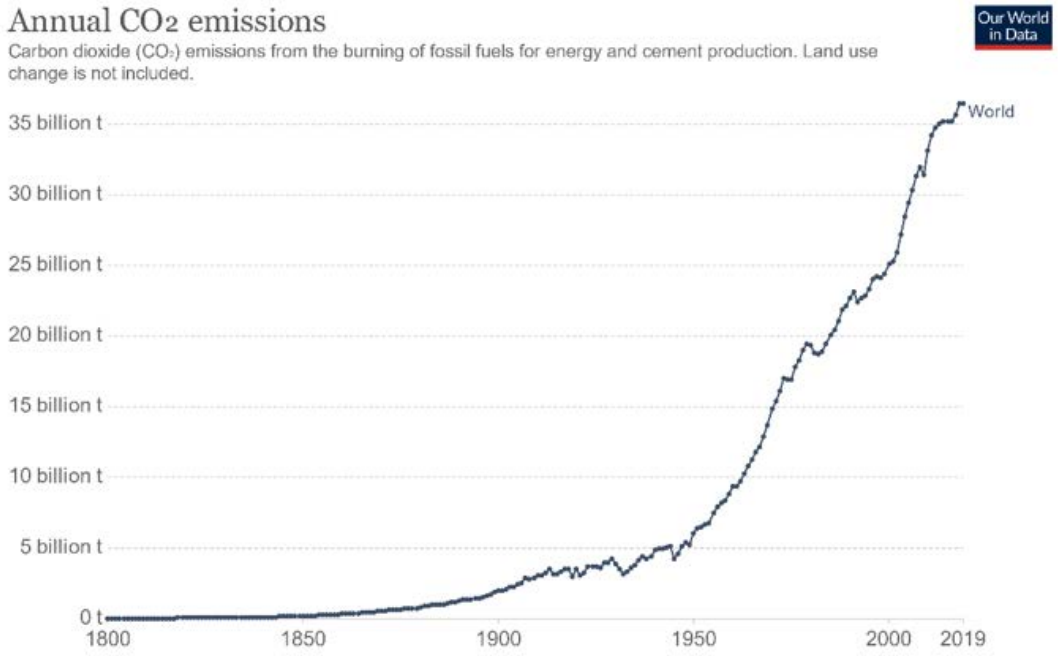

Source: Author

This simple scheme can be easily applied to the CO2 emissions taxes, that should be a short term priority, in order to evaluate them rationally since according to the IPPC, despite the current taxes, CO2 emissions do not collapse but increase (with a lower growth rate). This conclusion leads to rethink the mechanism of the CO2 taxes. In theory, a carbon price is assumed to share the pollution damages and induce a change in behaviours by promoting cleaner technologies and financial innovations to tend toward the ecological transition and *in fine* renew the economic growth restrained by pollution. To price the CO2 emissions there are two well-known methods: ETS[43] and the carbon price. The following

[43] Cf. sub-section 3. 2.

paragraphs is dedicated to the second method. According to the High-Level Commission on Carbon Prices report co-organized by Joseph Stiglitz and Nicholas Stern in 2017[44], the taxes should be around at $40-80 per tonnes by 2020 and $50-100 per tonnes by 2030. The carbon taxes could be an efficient tool to curtain the evolution of the CO2 emissions if the price is dissuasive. In May 2021, the EU carbon price hits 50 euros per tonnes, which reaches the target defined by the High-Level Commission on Carbon Prices report (Reuters, May, 4, 2021). However, this target seems to be not sufficient to drastically reduce the CO2 emissions, as demonstrated by the CO2 time series trajectory (Chart-4-).

Annual world CO2 emissions from 1800 to 2019 Chart-4-




Note: CO2 emissions are measured on a production basis, meaning they do not correct for emissions embedded in trade goods.

Source: Global Carbon Project: Carbon Dioxide Information Analysis Centre (CDIAC)

For the pricing exercises, it is delicate since a granular approach should be highly recommended to propose differentiated taxation system related to the level of pollution of each entity. Before, using such a tool, numerous efforts should be done to reinforce the data quality and analysis scope (i.e. increase the size scope, scope 3 mandatory etc.).

The taxation tools should be fair and in line with the famous "polluter pays principle".

To conclude this sub-section, the interlinkage between the both methods (bottom-up and up-down) is suitable and it may be a good approach to improve the data gap for a better understanding of the climate change challenges.

44 https://static1.squarespace.com/static/54ff9c5ce4b0a53decccfb4c/t/59b7f2409f8dce5316811916/1505227332748/CarbonPricing_FullReport.pdf

The next section proposes potential recommendations to store all sustainable information collected given the current patchy visibility.

## 4.2. Statistical store tools: Dashboard and Repository/catalogue

To increase the use and the visibility of the sustainable variables, several storage tools are required. The tendency is to propose dashboard or a repository/catalogue.

According to the Statistics Committee's Expert Group Climate Change and Statistics (STC-EG CCS) consultation carried out last year with the involvement of the ESCB and SSM users' committees[45], there is a huge demand for qualitative and quantitative databases for analytical purposes (at macro, micro and meso-economics levels). From the same consultation, several interesting and specific conclusions have emerged. Indeed, the shares of commercial and non-commercial database are respectively 47% and 53%. This means that private database providers are not negligible given their weights in the studies surveyed by the Expert Group. It is well known that for commercial database, there is no transparency and therefore the data quality is questionable. Nevertheless, we cannot exclude the fact that private providers are an alternative solution for the user's analytical reports and/or research works, Besides, the database scopes are emissions statistics (about 49%), transition related indicators (36%), physical risk statistics (7%), and forward looking tools (around 8%). It is obvious that the climate change question has occupied an important place in the economic and political scene; however, the sustainability scope cannot be reduced to the climate change scope. It should be welcome to enlarge the scope in order to deal with sustainability problematics that include climate change, and then fully understand the future analytical challenges. Remind that the user's empirical models/works are conditioned by the database availability and the data quality/availability.

Moreover, the absence of an overview of existing indicators and data sources, as well as of structured and user-friendly access procedures to the data sources, is considered an important obstacle to be overcome in order to facilitate sustainable data search/knowledge. In addition, the users have also underlined the urgency of the climate change databases. To answer to this urgent request, it is suitable at a first stage to provide information on the database availability thanks to a synthetic and/or friendly user interface. Several solutions exist but only two instruments are taken into account to limit the scope: data repository/catalogue and dashboard.

The present paragraph is dedicated to the presentation of these two approaches. The aim is twofold. The first goal is to shed light on the advantages and the drawbacks of each of these two tools. Of course, as the methodological scope is different it is not possible to conclude that the repository/catalogue is superior to the dashboard or the opposite. The conclusion is that these two approaches are not substitutable but complementary.

The second goal is to demonstrate the necessity to set up on the very short term a repository/catalogue rather than a dashboard, since the first tool provide more general information needed by users.

This orientation (to build the data repository/catalogue) is based on the several European and international initiatives to provide information on the climate change related risks (or on the sustainability).

[45] https://unece.org/sites/default/files/2021-03/S4_5_CC_and_financial_Fortanier.pdf

We start by defining these different tools and expose the main advantages and drawbacks for each approach (see Table -6-).

A dashboard is a set of few selected variables/indicators aiming to provide information on specific topics, climate change for instance. Hence, it is a data visualization instrument, which permits to users to have a synthetic picture of the selected theme. Even non-experts can easily understand the content and the future trends in case there are forecasting exercises. Given the few numbers of variables and of data and graphs, the phases of implementation, automation for the calculation/building process and updating are quite easy to realize. However, this smart and dynamic tool may be not enough flexible in case of rapid changes. Each new variable introduced in the dashboard requires discussions or debates, the same occurs in case of variables withdrawals. Besides, the first step of building the dashboard, which is the selection of the indicators or metrics etc. to measure a phenomena, takes time and the selection may be rapidly obsolete in case of rapid state of change. In addition, some dashboards have not changed since years. This denotes a kind of lack of flexibility. Moreover, it is a very difficult exercise since with few variables/indicators the dashboard is assumed to offer consistent information on specific problematics. The risk of such approach is also the lack of realism given its simplicity.

As shortly exposed in the former sections, for the climate change, there are several European and international initiatives, particularly in the information collection. We present only 4 dashboards without entering into details since it is outside the section's scope; however, it is interesting to briefly expose them in order to deduce some lessons and current trends.

We can cite as a first example the IMF dashboard that takes into account 11 key experimental indicators related to 4 topics (Economic Activity and Climate, Cross-Border, Financial, Physical and Transition Risks, and Government Policy). The principal target of the IMF dashboard is to measure the impact of climate change on the economies[46].

The NGFS dashboard considers several key indicators for 21 jurisdictions reported in 6 items (Real economy, Reporting, Risk, Mobilization, Regulation, and Global initiatives). The goal of the dashboard "on scaling up green finance" is to collect a group of optimal variables to monitor, measure and better understand the conclusions related to efforts to green economies/or the financial system. The next step is to develop a repository[47]. All these store exercises have emphasized on the financial aspect of the climate change that is in line with the NGFS mandate.

The OECD has also published specific dashboards on the green growth[48] or on the carbon pricing[49], which are outstanding and fruitful.

Amongst non-European countries dashboard initiatives, we can cite the US version dashboard[50] given its advance in this field. However, it is largely oriented towards the physical[51] and transition[52] risks. Like the US dashboard, the UK version[53] deals with the physical and transaction risks.

Given the relative novelty of the climate change problematics, the current dashboards (i.e. IMF and NGFS) aimed to capture the impact of climate change on economies are in a preliminary phase. We welcome these interesting initiatives; however, they are all oriented towards the climate change impacts.

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[46] https://climatedata.imf.org/
[47] https://www.ngfs.net/node/365521
[48] https://www.oecd.org/greengrowth/48224574.pdf
[49] https://carbonpricingdashboard.worldbank.org/what-carbon-pricing
[50] https://www.climate.gov/
[51] Acute and Chronic risks
[52] CO2 emissions
[53] https://www.metoffice.gov.uk/hadobs/monitoring/dashboard.html

Unfortunately, the climate change partly materialized by the global warming does not permit us to see the wood for the trees. In a general manner, the dashboards are goal oriented tools, they all take into account specific topic (CO2 emissions or green finance or biodiversity loss etc.).

The solution to tackle the limits of the dashboard's exercises is likely to complete and integrate them with a data repository/catalogue tool that enlarges the scope and the informational content, for instance.

A data repository/catalogue is a neatly optimal inventory of available datasets across all sources (e.g. both private and public data providers). It is very useful for the users since it gathers main relevant information about the databases associated to their sources, via a structured layer for information. The data repository/catalogue is ordered and accessible for all users; it also provides information about the access identification codes, the units, the definitions, the frequencies, the start and end dates etc. The main advantages of this instrument are its potential "exhaustiveness", its flexibility and its friendly user interface. The main drawbacks are its time consuming nature, especially during the first implementation steps and the necessity to avoid the overabundance of information. The data repository/catalogue should be optimally calibrated since too much information kills information.

There are several data repositories/catalogues from different data providers; however, they do not take into account all the sources of the sustainable databases, as described in Section 3. This kind of tools is crucial for the users. Table -6- summarizes the pros and cons of each tool.

Dashboard and Repository/catalogue: Pros and Cons Table-6-

| Tools | Pros | Cons |
|---|---|---|
| Dashboard | • Time saving approach for the producer<br>• Smart and customisable presentation<br>• Data and Graphs easily implemented and automated<br>• Synthetic approach (Presentation of key indicators for specific topics)<br>• Drill rapidly into details<br>• Real time approach<br>• For all users | • Limited information<br>• Lack of realism<br>• Limited objective<br>• Not flexible in case of information volatility (ex. Short term exogenous shocks) |
| Repository/Catalogue | • "Exhaustive" approach<br>• Real time approach<br>• Easily automated for the update step<br>• For all users | • Time consuming approach (short-term implementation step)<br>• Overabundance of information /Too much information kills information |

Source: Author

To conclude this section, data Repository/catalogue and dashboard are not substitutable but complementary. They are two different approaches aimed at corresponding to the users' needs. According to our knowledge, there is no data repository/catalogue which integrates all different types of data sources and the limits of all data introduced. Moreover, very few information on the quality of the data. The repository/catalogue should precise the quality of all data and particularly of the commercial data that are opaque and therefore questionable.

All world database included in the public catalogue should be cautiously verified and information on the scope, the definition, the frequency etc. should be integrated to provide the most exhaustive information and permit to the users to know exactly what they are measuring in their empirical works. In case of no information or insufficient information for the database reported in the catalogue, an informative notification should be available or introduce green orange and red flags to rank the data quality.

After having briefly justify the necessity to build a data repository/catalogue very soon, we describe in the next section, in a practical manner, some recommendations reflecting short term priorities.

## 4.3. General recommendations

The recommendations are related to the database availability. The methodologies, metrics and tools require a deep understanding of sustainability concepts, which is not easy but not impossible given the nature of the challenges. The first challenge is to find common basis for the concepts and define the EU harmonised taxonomy that is not ready today but will be available in 2022 according to the EC (European Commission). This step is the cornerstone of the sustainable finance and growth since the two variables are interlinked, there is no growth with finance and *vice versa*. In the meantime, the authorities should start defining common labels list of the companies that are in line or not with the Paris Agreement on climate change and in the case of non-alignment, they should define several thresholds that are characterised the firms climate change goals. This list of companies will be a tool for the investors that are aware of the ESG benefits for the sustainable development and orient their investment towards climate change project, for instance. However, the main obstacle to such recommendation is the companies 'behaviour that refused to be classified because of the fear of the famous 'blame and shame' and the loss of their reputation. The legal authorities should also provide information to explain the necessity of the transition companies list that also reports deadlines from today to 2050 (date for being clean or sustainable) with intermediate goals. The approach will also be fruitful for banks, insurances or any institutional investors and of course, for the authorities that can measure the efforts realized by firms and evaluate the progress made to converge towards the Paris Agreement requirements and adjust timely their policy tools aiming to tackle the climate change risks. However, we have to bear in mind that the lack of database is also a huge challenge for authorities and particularly for the central banks who are in charge of the financial stability and stability prices and *in fine* economic growth rate.

As already underlined, it might be interesting to build a repository/catalogue characterized by its exhaustiveness and its flexibility. However, it may be useful to develop a set of recommendations classified by priorities for is building that means we should define short term medium term and long term perspectives and/or targets.

In this sub-section, we will explore three sets of coordinated recommendations. We must bear in mind that it is a provisory/proposal frame and it may be modified at any time and improved in the very short term. It is not an exhaustive list of recommendations for the short term.

1/ The first set of recommendations is a potential world cooperation between the main actors of the statistics production.

We can for instance imagine a collaboration between all statistics authorities IMF, World Bank, BIS, OECD, Eurostat, the Eurosystem statistical Directorates and National ESS during the first phase and extend this collaboration to other actors such as academics institutions, Governmental and non-governmental organizations etc. (phase 2). The third phase is to extent to commercial providers since their data quality is questionable and they are utilized by an important share of users.

A central authority experienced on the data centralization and disclosure (such as IMF, OECD or G20) could be the main statistics actor in setting up and maintaining the catalogue for transaction cost reasons. In this case, an analysis of organizational settings would welcome. By organizational settings, we mean resources and responsibilities. The goals are to create sustainable statistics debates on a regular basis on methodologies and commonly develop economic and financial indicators in line with the ESG concerns. Reliable and harmonized database disclosures is essential to bring up more detailed information about the ESG issues and more particularly the climate change given its priority nature,

This first set of recommendations is justified by the economies of scale, the creation of synergies, complementarity developments by combining human and financial resources and inconsistency removals.

2/ The second set of recommendations is a classification of risks data according to priorities. As previously exposed, currently there are several granular and aggregated information assumed to measure the physical risks and it may be easier to start the catalogue with such databases and rapidly extend it to transition risks and other risks. Since the building of the catalogue is very heavy in terms of resources; so the setting up activities may be last between several periods (that we have to roughly precise). However, the EG STC CCS survey has shown that the transition risks issues where omnipresent in the NCBs works, it may be then more suitable to start by this risk to answer to the users' needs. As the two risks are interconnected it is possible to collect simultaneously the two risks, but the task is complex. Remind that the transition risk takes into account several items surrounded by uncertainties (i.e. Policy change and reputational impacts, consumer preferences, new technologies etc.), which are not easy to capture with accuracy. Granular collection should be the priority to fully understand the ESG challenges and essentially the climate change challenges.

3/ The third set of recommendations is related to the quality of the database and the harmonization. As already underlined the weight of commercial data in user's works and especially in the supervisors and regulators works is relatively important. There is a kind of asymmetrical information between the users and the providers this significates we have not enough information about the quality of the content and the scores or definition used to classify the firms as sustainable or not for instance. To set the idea on a simple example, we make use of the carbon firm's classifications. For instance, the identification of the low/high carbon firms is still puzzling that is not normal given the climate change emergency. At this stage, we should also note the key necessity of harmonization between the ESG criteria, definitions, and classifications, etc. since "the devil is in the details". Indeed, according to the Intergovernmental Panel on Climate Change (IPCC) report, there are 5 major industry sectors assumed to be highly polluting. More precisely, with the IPCC classification, the Toyota Motor Corporation is listed as a high carbon emissions firm whereas the MSCI ESG Ratings classify the same firm as a low emission company (Choi et al., 2020). These divergences should be avoided at the very short term because they are not consistent. Moreover, they raise again the question of the reliability of private/commercial data providers, which are largely used by academic papers and the central bank's researchers/and or analysts.

We need experts (biologists, mathematicians, physicians, economists, financial auditors etc.) dedicated to verify the content of commercial data and other databases (i.e. NGOs). In case we have no information the users will be informed by the label no information on the content for instance. The following table resumes the content of our provisory recommendations.

Recommendations for the short term — Table -7-

| **Recommendations** | **Phase 1** | **Phase 2** | **Phase 3** |
|---|---|---|---|
| **R1** Collaboration | Mandate an International Authority to endorse the role of leader<br><br>Main actors for the collaboration: BIS,IMF, OECD, WB, Eurostat, Eurosystem statistical Directorates and National ESS etc. | academics institutions, Governmental and non-governmental organizations | Commercial providers |
| **R2** Risks data priority | Transition risks | Physical risks | Other risks |
| **R3** Data quality control and harmonization | Collect information data (granular and aggregated) | Involve experts in the informational content analysis | Provide labels of quality to users. |

Source: Author

The three phases are flexible, interchangeable and interactive, the time length of each phase is random. It depends on several factors such as the negotiation periods, the acceptation/ refusal of each actor and of course exogenous events. Moreover, some risks are interlinked; the physical risks and the transition risks are totally nested. For instance, it is suitable to collect simultaneously CO2 information (financial and not financial) since their emissions are interconnected to the financial system. As already underlined, the banks report CO2 assets (from firms) in their balance sheet. The target of Table -7- is to propose an orderly and efficient road map/picture and more clarifications of the steps sequences.

After this indispensable step of database, regulation and adjustment policies should be more efficient, since better calibrated and easier to apply given the future common standards.

# 5. Conclusion

In summary, it is obvious that regulation authorities as central banks have to participate actively to the promotion of the sustainable finance (Volz 2017; Dikau et Volz 2019; Jeffers and Plihon, 2020; Coeuré, 2021) and the disclosure of database available for all users (central banks, universities, private or public research institutes, NGOs, etc.). However, they should not be alone to find pro-climate solutions.

Then, from a database scope, there are several lacuna and the urgency is to provide qualitative and harmonized data that will permit to develop stress tests that are indispensable to measure the resilience of the financial system, heart of productive system. Central banks and other public or private actors need robust and reliable statistics to preserve the common goods, particularly the planet, which currently is not the case. Some relevant sustainable database (at different level granular, sector, countries) exist that deserve to be optimally corrected, disclosed and used. The spread and the sharing of the database are the key of better understanding of the impact of the climate change on the countries, for instance. Indeed, the identification of imbalances are essential and their corrections via calibrated tools/instruments are indispensable.

World financial regulators should extend the sustainable or climate reporting to all listed companied as well as asset managers to be in line with the increasing demand of investors for disclosure and with the need of users to understand fully the sustainability.

The sanitary crisis has reinforced the need of data disclosure and it should be the first step to increase our needs to collect timely reliable information.

In addition finance and informatics, combined with artificial intelligence, technologic innovations cannot be separated from the energy consumption that raises the question of the conciliation of the increase of the energy utilization and the digitalization, for instance. For the digitalization sector, the database are totally incomplete and there are lacuna in terms of indicators. This point should be treated simultaneously with the sustainability data collection. Besides, the role of AI coupled with big data should not be neglected to increase our knowledge on sustainable issues; however, as pointed AI is energy consuming and currently there is no sustainable energy at a large scale that could limit the carbon footprint.

From the policy side, budget policies, particularly fiscal measures should also sustain the monetary supervisors' actions. Both monetary and budget policies should be coordinated to limit or annihilate totally the planet's damages related to anthropocene and capitalocene (Moore, 2017).

Moreover, the scope is global and success in international cooperation in climate change actions depends on various determinants because numerous and different players are involved and they have different goals and perspectives. Central banks intervene to meet their policy targets, governments participate to define national policies and reach their goals, firms want to be in line with the public ESG concerns, academic researchers pursue their academic interests etc. To match all these interests, an optimal use of top-down and bottom-up approaches should be rapidly efficient.

Nowadays, transition risks cannot be analyzed without taking into account the uncertainty, accented by new environments (technology, ecology transition, etc.); economies are plunged into a new environment where the "unknown unknowns" theory (Logan, 2009) is omnipresent and this assertion is reinforced by the recent ongoing sanitary crisis. A U-theory (Scharmer, 2016 and Scharmer and Kaufer 2018) may be useful to solve partly the issue of environmental finance. Concisely, the U-theory enables the possibility to find the best solution for a group or an organization. All agents have to participate

actively to the project. There is no leader to impose solutions or discussions. The interactions between agents create common solutions thanks to an interactive process. The solution prototype are evolving and therefore be can be continuously improved by all participants. The U- theory is a method that considers the uncertainty as new possibilities reservoirs to solve thorny and theoretically unsolvable questions. The climate changes create risks and the solutions bring opportunities. We should act in a timely manner; propose fiscal and monetary stimulus packages to boost resources and sustainable growth; to prevent risks and utilize opportunities. All environment actors have to adapt optimally to this new paradigm. Accordingly, the economic policy responses to the environmental emergency need to match this specific environment, posing a challenge to both economists and decision makers.

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# Appendices

Table 1.A. Sources, incentives, objectives and sectors in sustainable finance definitions and taxonomies in EU

| | LU Definitions | EU Taxonomy | France Definitions | Netherlands Definitions |
|---|---|---|---|---|
| **Sources** | | | | |
| Sovereign Green Bond | X | | X | X |
| Green loans definitions in legislation[54] | X | X | X | X |
| **Incentives** | | | | |
| Interest rate incentives | X | | X | X |
| Tax incentives or subsidies | X | | X | X |
| Monetary policy/collateral incentives | | | | |
| **Objectives** | | | | |
| Social objectives included | X | X | X | |
| Climate change adaptation | X | X | X | X |
| Climate change mitigation | X | X | X | X |
| Water and marine protection | X | X | X | X |
| Pollution prevention and control | X | X | X | X |
| Waste and recycling | X | X | X | X |
| Ecosystems/Biodiversity | X | X | X | X |
| **Sectors covered** | | | | |
| Nuclear[55] | X | ? | | |
| Gas with emissions threshold[56] | X | X | | |
| Clean fuel | X | | | |
| Clean Coal (supercritical) | X | | | |
| Hydro | X | X | X | X |
| Solar | X | X | X | X |
| Wind | X | X | X | X |
| Biofuels (biogas, biomass) | X | X | | X |
| Power Transmission and distribution | X | X | X | X |
| Energy efficiency | X | X | X | X |

[54] http://legilux.public.lu/eli/etat/leg/loi/2018/06/22/a521/jo

[55] There is no nuclear power plant in LU, however, the nuclear consumption represented 10,7% of the total energy consumption in 2019 . For the period 2009-2019, there is a great decrease in nuclear consumption (about -54%). This trend is in line with the government will to eliminate this source of energy at term.

[56] https://www.oecd.org/tax/tax-policy/taxing-energy-use-luxembourg.pdf

| | | | | |
|---|---|---|---|---|
| Green buildings/energy efficiency in buildings | X | X | X | X |
| Private passenger transport | X | X | X | X |
| Public passenger transport | X | X | X | X |
| Freight rail | X | X | X | X |
| Waterborne transport | X | X | X | |
| Water infrastructure | X | X | X | X |
| Clean water supply | X | X | X | |
| Forestry | X | X | X | X |
| Fisheries and aquaculture | No data in this field | X | X | |
| Preparation, re use, recycling | X | X | X | X |
| Waste to energy | X | X | X | X |
| Clean steel | X | X | | |
| Clean aluminium | X | X | | |
| Clean cement | X | X | | |
| Low carbon technologies | X | X | | |
| Hydrogen[57] | X | X | | |
| Information and Communication Technology | | X | | |

Source: OECD (https://www.oecd-ilibrary.org/sites/cdb1fb77-en/index.html?itemId=/content/component/cdb1fb77-en#section-d1e134

Table- 1.A- demonstrates that there are several variables assumed to evaluate the greenness degree of economies. It is obvious that common elements are available, which is a good news. However, the main tasks are to verify the content of each sub-items and ensure the database reliability, which is very difficult because of the data gap. This point reinforces the idea of the role of national banks to collect from several reporting outstanding information related to the greenness, which are compiled by the ECB. The advantage of the ECB compilation is that all variables are in line with the European guidelines and definitions.

[57] https://fedil-echo.lu/focus/hydrogen-to-decarbonise-luxembourgs-industrial-sector/

Table –A.2- Climate change risks and prudential tools activations

| | | | | Synthetic risks (Combination of physical transition and liabilities risks) | | |
|---|---|---|---|---|---|---|
| | | | | | | |
| Financial cycle and other key macro-economic variables (GDP, inflation, unemployment, etc.) | expanding phase of the financial cycle | Healthy economy | without crisis | Preventive green policies. | Partial implementation of green policies. | Extensive implementation of green policies. |
| | | Unhealthy economy | | Policies to support sustainable growth and jobs. | Partial implementation of green policies. | Extensive implementation of green policies. |
| | Recession phase of the financial cycle | Healthy economy | | Preventive green policies. | Partial implementation of green policies. | Extensive implementation of green policies |
| | | Unhealthy economy | | Policies to support sustainable growth and jobs. | Partial implementation of green policies + Policies to support sustainable growth and jobs. | Extensive implementation of green policies. |
| | | Healthy economy | with crisis | Preventive green policies. | Partial implementation of green policies. | Extensive implementation of green policies. |
| | | Unhealthy economy | | Policies to support sustainable growth and jobs. | Partial implementation of green policies + Policies to support sustainable growth and jobs. | Extensive implementation of green policies + Policies to support growth and jobs. |

Notes: Shaded boxes indicate that these situations no longer exist. The green orange and red rectangles represent low, medium and high risk, respectively.

Potential decision tree of probabilities related to climate change risks


With Ei is the states of nature (i=1, 2 and 3).

$(p_{JR/Ei})$ is the conditional probability (probability of a JR occurrence given Ei with J=transition (T), physical (P) and liability (L) risks).

TR, PR and LR are respectively the transition risk, the physical risk and the liability risk.

For the colour of the thresholds, we use a basic rule. For each branch of the decision tree, we select the worse situation for the aggregated risks.

This simple representation can easily be generalised to n states of nature and develop more scenarios.

[58] By risks we mean risks that are purely ecological and are evaluated and prioritized by the scientific community. The evaluations of the risks require reliable data.

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EUROSYSTEM

# Statistical data needs on sustainable finance for central banks

International Conference on «Statistics for Sustainable Finance»

14-15 September 2021, Paris.

Sabbah Gueddoudj

Statistics Department

# Introduction

- How to apprehend the sustainability notion: definition vs taxonomy.
  LU taxonomy version (Section 1)

- Sustainable database needs and the role of central banks (CB):
  Some European experiences.
  LU sustainable bonds (Section 2)

- Recommendations for CB database users
  Repository and international cooperation (Section 3)

# Section 1 Definition vs Taxonomy (1/2)

- Definitions

a- Pricewaterhouse Coopers Consultant (2013)

b- Höhne et al.(2012)

c- United Nations Environment Programme (UNEP)

etc.

Why should we condense the complexity of a variable into a unique definition (Lindenberg, 2014)?

# Section 1 Definition vs Taxonomy (2/2)

- Taxonomy sample for EU, FR, LU and NL (based on OECD works)

| | LU Definitions | EU Taxonomy | France Definitions | Netherlands Definitions |
|---|---|---|---|---|
| **Sources** | | | | |
| Sovereign Green Bond | X | | X | X |
| Green loans definitions in legislation[4,5] | X | X | X | X |
| **Incentives** | | | | |
| Interest rate incentives | X | | X | X |
| Tax incentives or subsidies | X | | X | X |
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| **Sectors covered** | | | | |
| Nuclear* | X | ? | | |
| Gas with emissions threshold | X | X | | |
| Clean fuel | X | | | |
| Clean Coal (supercritical) | X | | | |
| Hydro | X | X | X | X |
| Solar | X | X | X | X |
| Wind | X | X | X | X |
| Biofuels (biogas, biomass) | X | X | | X |
| Power Transmission and distribution | X | X | X | X |
| Energy efficiency | X | X | X | X |
| Green buildings/energy efficiency in buildings | X | X | X | X |
| Private passenger transport | X | X | X | X |
| Public passenger transport | X | X | X | X |
| Freight rail | X | X | X | X |
| Waterborne transport | X | X | X | |
| Water infrastructure | X | X | X | X |
| Clean water supply | X | X | X | |

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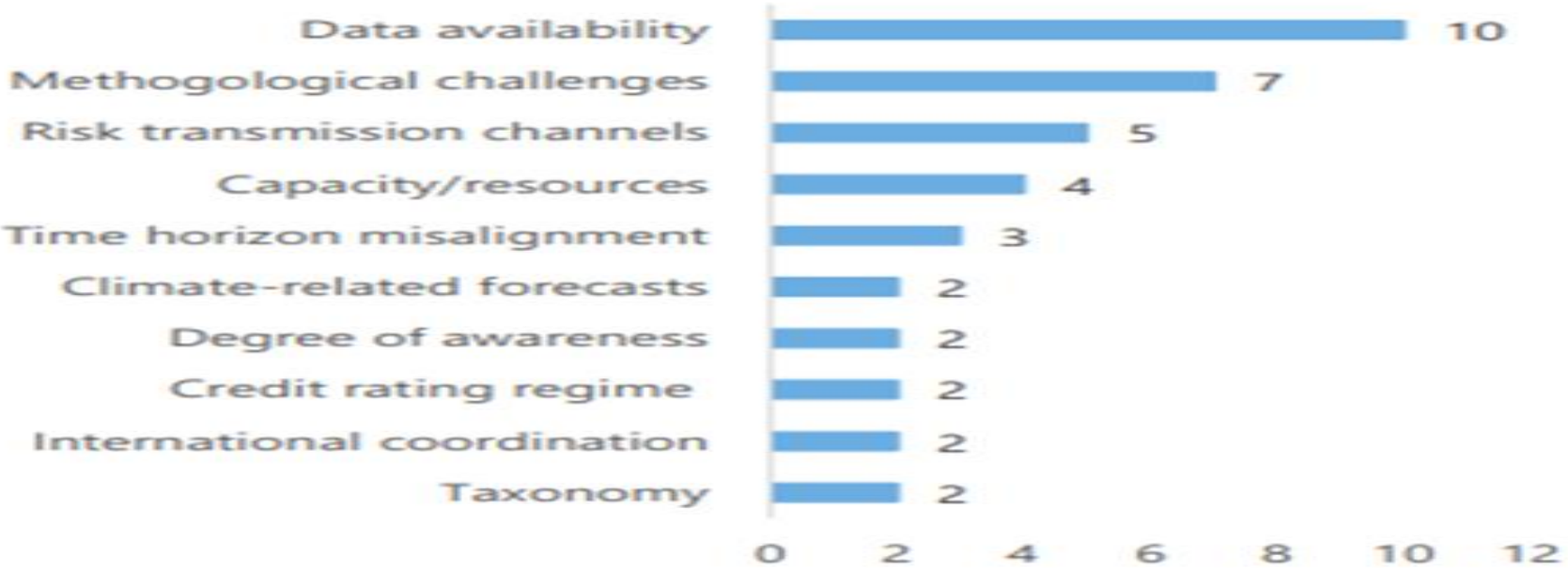
# Section 2- Sustainable database needs and the role of central banks: European initiatives (1/2)

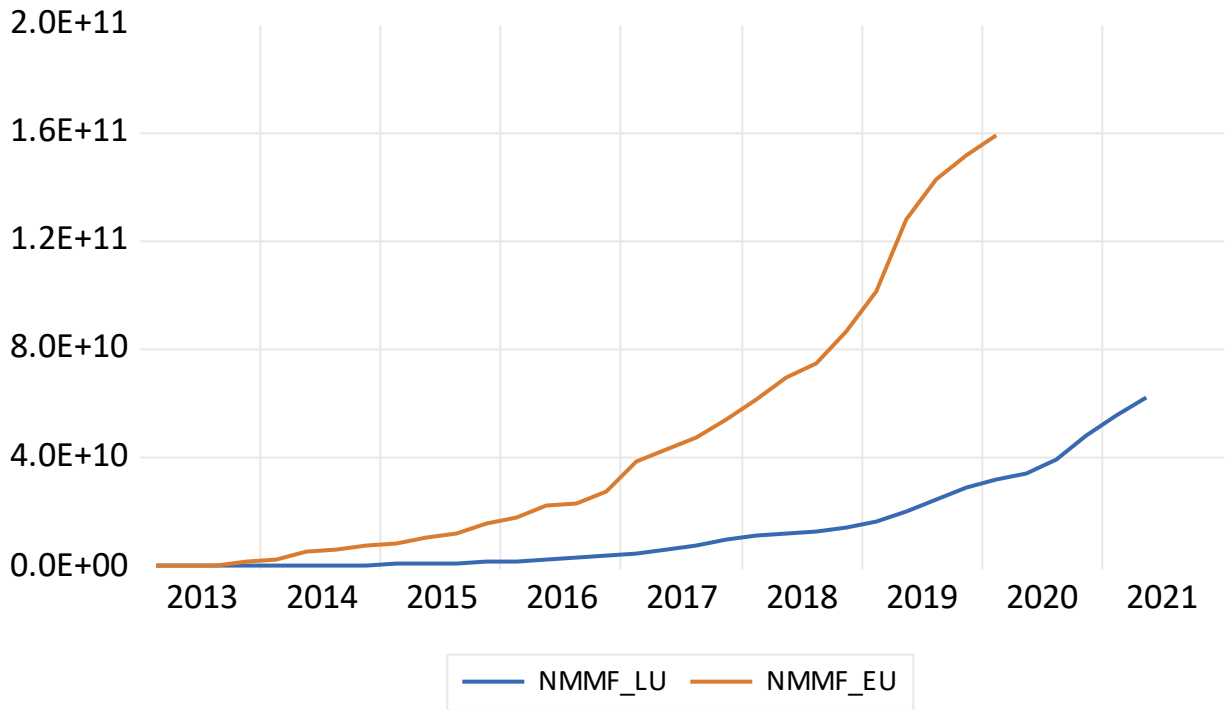
- EU Surveys




Source: Basel Committee

# Section-2- Sustainable database needs and the role of central banks: European initiatives (2/2)

- European and Luxembourg Sustainable bond holdings time series (Quarterly frequency, from 2013Q1 to 2021Q1, billion Euro)

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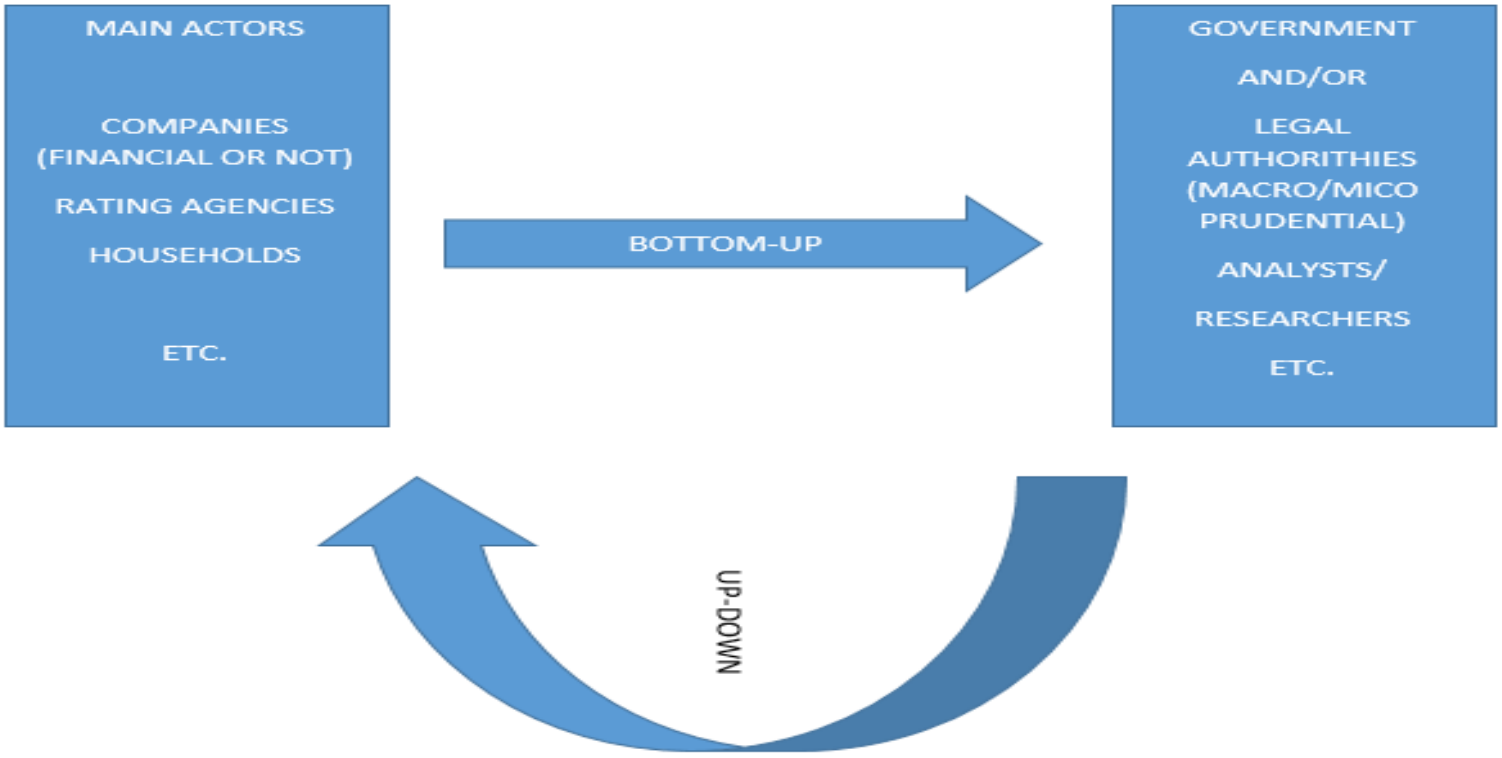
# Section-3- Recommendations for CB database users (1/3)

- Bottom-up and top-down approaches



# Section-3- Recommendations for CB database users (2/3)

- Dashboard vs Repository (i.e. Catalogue)

| Tools | Pros | Cons |
|---|---|---|
| Dashboard | • Time saving approach for the producer<br>• Smart and customisable presentation<br>• Data and Graphs easily implemented and automated<br>• Synthetic approach (Presentation of key indicators for specific topics)<br>• Drill rapidly into details<br>• Real time approach<br>• For all users | • Limited information<br>• Lack of realism<br>• Limited objective<br>• Not flexible in case of information volatility (ex. Short term exogenous shocks) |
| Repository/Catalogue | • "Exhaustive" approach<br>• Real time approach<br>• Easily automated for the update step<br>• For all users | • Time consuming approach (short-term implementation step)<br>• Overabundance of information /Too much information kills information |

# Section-3- Recommendations for CB database users (3/3)

- Orderly roadmap for a comprehensive and reliable data catalogue

| Recommendations | Phase 1 | Phase 2 | Phase 3 |
|---|---|---|---|
| **R1** Collaboration | Mandate an International Authority to endorse the role of leader<br><br>Main actors for the collaboration: BIS,IMF, OECD, WB, Eurostat, Eurosystem statistical Directorates and National ESS etc. | academics institutions, Governmental and non-governmental organizations | Commercial providers |
| **R2** Risks data priority | Transition risks | Physical risks | Other risks |
| **R3** Data quality control and harmonization | Collect information data (granular and aggregated) | Involve experts in the informational content analysis | Provide labels of quality to users. |

# Conclusions

- The role of CB is crucial as data producers and data users given their missions and their historical backgrounds.

- Data lacuna, lack of quality and long term/historical time series unavailability are obstacles to the CB missions.

- Climate change is global therefore international cooperation is required.

  ‘’If you want to go fast, go alone; if you want to go far, go together’’ (African proverb).

- Inclusion in the data collection of the digitalisation and the artificial intelligence (IA) sectors since 1/ they are energy consuming and 2/ they play (and will play) an important role for the data collection today (and tomorrow).

Thanks for your attention. For any questions and/or suggestions, do not hesitate to contact us at

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