Review



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Posted Date: 22 September 2023

doi: 10.20944/preprints202309.0956.v2

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# The Sustainable Material Culture (SMC): A Review

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**Abstract:** We confidently approach current issues in Green Finance (GF) from the perspective of an international organization, where the first author has previous experience as a support assistant. In fact, the economy of the EU (European Union) is deeply involved in the changing needs related to the dramatic consequences of climate change and environmental degradation, which has placed the needs of a more sustainable economy at the top of the international agenda. The environmental, social and governance (ESG) aspects are marginally addressed to arouse a major interest in questions raised by green financial products which require long-term profit expectations, and which above all contain a margin of risk that is difficult to calculate in the landscape of traditional financial instruments. Through a careful approach akin to artificial intelligence research methods, we attempt to "materialize" at least the most visible clues of this fashionable economic shift through what we call SMC (sustainable material culture) objects. The presented SMC objects serve as tangible representations of sustainable practices and can promote awareness and action incorporating into everyday life and business practices a powerful reminder and catalyst for a shift towards more sustainable investment and consumption patterns.

**Keywords:** sustainability; segments of economics; complexity; google search; green finance (GF); debt service suspension initiatives (DSSIs); artificial intelligence (AI)

## 1. Introduction

Culture is concerned primarily with the way people act. The actions, then, of manufacture and use, and the expressed theories about the production, use, and nature of material objects constitute the data of material culture. In their relation to culture, artifacts and materials are to be classed in the same category as the substances, such as minerals, flora, and fauna, which compose the environment in which humans live. To inquire into sustainable material culture (SMC) as a fruitful way to let make new economic activities be the first to respond to changing conditions both for climate transformation (CT) and green finance (GF), we consider a group of SMC events are consistent manifestations of the human response to unsustainable innovation system. SMC objects are often products or artifacts that are designed with sustainability in mind. They may use fewer resources, be made from recycled materials, or have a longer lifespan. By studying and promoting these objects, we can encourage more sustainable consumption patterns, reducing the environmental impact associated with resource extraction and waste generation.

In addition, economic growth is traditionally measured by increases in the production and consumption of goods and services. However, this growth can be environmentally unsustainable if it leads to excessive resource consumption, pollution, and habitat degradation. SMC objects can be seen as exemplars of a more sustainable form of economic activity, where growth is decoupled from

 doi:10.20944/preprints202309.0956.v2



negative environmental consequences. In particular, GF refers to financial products and services that i. encourage sustainable investments, ii. promote climate change mitigation and adaptation, and iii. support the transition to a low-carbon economy. GF covers various financial instruments, including loans, bonds, equity, and insurance.

The ESG (Environmental, Social, Governance) factors of an economic or project activity brought forward as new political priorities already in the 2016 Paris Agreement on Climate Change have encapsulated both CT and GF into the request for significant shift in the allocation of resources. For its part the EU (European Union) Commission has indicated that sustainable finance has two urgent imperatives: i. improving the contribution of finance to sustainable and inclusive growth by funding society's long-term needs, and ii. strengthening financial stability by incorporating ESG factors into investment decision-making **[1] p.1** (European Commission, 2018).

While it is true that GF seeks to rebalance and redistribute environmental risks in the long term, its primary objective is to promote sustainable investments and support the transition to a low-carbon economy. This is achieved by allocating capital and funds to investments that are beneficial to the environment, such as renewable energy, energy efficiency, sustainable agriculture, and green infrastructure. GF is also concerned with maintaining financial stability by identifying and managing CT. It seeks to ensure that financial institutions and markets be equipped to manage climate-related risks and opportunities in their operations and investment decisions, and to promote the development of green financial products and services. One of the key goals of GF is in fact to support the transition toward a sustainable and resilient economy by aligning financial flows with the objectives of the Paris Agreement (December 2015) and of other international agreements on climate change and sustainability. This includes *i*. assessing and managing climate-related risks, *ii*. integrating climate considerations into investment decisions, and *iii*. promoting transparency and accountability in reporting on environmental impacts.

The 19th century economist V. Pareto and his efficient vs. inefficient economic model are then evoked in order to demonstrate that the effectiveness of economic strategies and associated tools is often coupled with a lack of performance or predictive accuracy. Economic strategies (especially those related to environmental policies) may be deemed effective based on certain criteria, such as Pareto efficiency, but they may not accurately predict real-world outcomes. In other words, a policy that appears to be efficient from an economic standpoint may not necessarily lead to the desired environmental results in practice. In the case of environmental policies, measuring the setting of objectives (including targets, indicators and deadlines) and the execution of policy instruments go hand in hand with effective governance, which thus must be diligent in planning and budgeting skills. To somehow slow down this mechanical displacement of economic objectives towards the penalization of efficiency, we therefore make appeal in the first part of the article to the contribution of "decision theory," which is mainly based on the field of a probabilistic literature expressed by the work of J.O. Berger in the early 1990s. We are making an appeal to the field of "decision theory" to counteract a trend toward overemphasizing economic efficiency, especially when it comes to policies or decisions that may have penalizing effects. propose that decision theory, with its roots in probabilistic literature and influenced by the work of J.O. Berger, offers a more balanced and comprehensive approach. This approach likely considers not only efficiency but also uncertainties, risks, ethical concerns, and other relevant factors when making decisions that have implications for society, the environment, or other aspects beyond economics.

## 2. Logics and Economics

Logics of economics and the implementation of ordinary reasoning guide our daily decisions and are embodied as an antechamber of sophistry and negative outcomes. This may be mostly true in the case of GF due to market volatility and forecast taking into account many areas and many economic predispositions and given the approximate composition of the panel of heterogeneous and undetectable investors in their assets and background. We claim our main hypothesis, namely that if one wants to express SMC manifestations related to GF instruments and tools, one must first and foremost look for examples in economics that show alignment with sustainable values. Ideally, they

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should also show lower when no biased ESG commissions or omissions (in terms of sustainability) to counter the dramatic consequences of climate change and environmental degradation. The neoclassical expectation of a rational agent is thus transformed in the article into an "exploiter" of price dynamics, with people dreamily believing in storytelling techniques on scenario-based forecasting, then suddenly able to shut down their own emotions and dive like a shark on its economic prey. As a matter of fact, green financial products can indeed involve certain risks that may be challenging to calculate or assess, particularly when compared to traditional financial instruments. Some of these risks include:

- Green Project Risk: The success and impact of green projects can be influenced by various factors, including regulatory changes, technological developments, and unforeseen environmental events. Assessing the risks associated with specific green projects can be complex.
- Market Risk: As with any financial instrument, green financial products can be affected by market volatility, interest rate changes, and shifts in investor sentiment. These factors can be challenging to predict accurately.
- Regulatory and Policy Risk: Changes in environmental regulations or government policies can impact the profitability and viability of green projects and, consequently, green financial products.

With an interpretative research technique opposed to robust Bayesian inferences such as Monte Carlo and other methods, i.e., the abductive model of inference by Delphi [2,3] (Brady, 2015) (Naisola-Ruiter, 2022), we therefore use personal matching and similarity-based inference drawn from examples we already knew before conducting our research on the SMC objects. A very simple kind of mathematical modeling for GF investments is then shown in sub-section 2.2. The suitable mathematical modeling for GF investments, which uses linear combinations of the latent variable 'SMC approximations' estimates the model relationships. Weighting and distance between GF instrument configurations provide simple SMC landscape modeling that drives sustainable development as required by the 2030 Agenda for Sustainable Development (SD). The term "participatory green economy" (GPE) refers to an economic system that emphasizes sustainability, environmental conservation, and inclusivity in decision-making processes. It suggests that various stakeholders, including the public, have a role in shaping and benefiting from this green economy Slogans and strong propositions of the international order indicate that a GPE can be the solution to guarantee environmental consistency with finance purposes. GPE is seen then as a solution to a potential conflict or inconsistency between environmental goals (such as sustainability and conservation) and financial objectives (such as economic growth and profitability). In other words, there is a growing consensus or belief within the international community that a GPE can reconcile the sometimes conflicting goals of environmental protection and economic prosperity. It implies that this approach aligns economic activities with sustainability and environmental goals, potentially leading to more consistent and environmentally responsible financial practices.

### *2.1. The efficient-Versus-Inefficient Model*

An efficient-versus-inefficient model is a way of characterizing a set of models or strategies that are used to make predictions or decisions. It is based on the concept of Pareto efficiency, which occurs when there is no other model or strategy that can make at least one person better off without making someone else worse off. The principle is often associated with the concept of a Pareto frontier, which represents the set of all possible allocations that are Pareto efficient.

In the context of the model or strategy set $\{(S_1, f_1), (S_2, f_2), \ldots, (S_n, f_n)\}$, the Pareto frontier would represent the set of all model-performance combinations that are Pareto efficient, meaning that no other model or performance combination can be found that would make one objective better without making another objective worse. In the contrary, inefficiency in a model or strategy occurs when there are other models or strategies that are better in terms of achieving one or more objectives without any additional disadvantages in achieving other objectives **[4]** (Staten & Umbeck, 1989). This means that there are other model-performance combinations that could be found that would make one

 doi:10.20944/preprints202309.0956.v2



objective better without making another objective worse—a violation of the Pareto efficiency principle.

In other words, inefficient models or strategies are those that fail to fully achieve all objectives possible, or that have weaknesses or trade-offs that could be improved upon by considering other models or strategies that perform similarly or better in some objectives without sacrificing performance in others.

By contrast, efficient models or strategies are those that achieve the best possible performance across all objectives, or that perform at a level that cannot be improved without compromising on performance in other objectives. The Pareto frontier represents the set of all efficient model-performance combinations, where all objectives are achieved as fully as possible with no trade-offs or weaknesses.

From a mathematical point of view, an efficient model is one that minimizes the prediction error or maximizes the predictive accuracy for a given set of data. Specifically, an efficient model is one that achieves the best performance among all feasible models, where feasible models are those that can be constructed using a given set of variables or features **[5]** (Jolliffe & Cadima, 2016).

### *2.2. Economics as a Complex System*

#### 2.1.1. Are GF (Green Finance) Investments "Trojan Horses"?

Many sectors and roles are involved in such economic change because the environment is portrayed "as a complex system," difficult to deal with in neoclassical linear economic models, and the subjects and expertise involved require even more social consent around financial goals and targets, and an ability to address social challenges with "Solomonic judgment." The reference to King Solomon comes from a famous story in the Bible, where he was faced with a difficult decision involving two women who claimed to be the mother of the same baby. Solomon's judgment, often cited as an example of wisdom and fairness, was to propose splitting the baby in two, with each woman receiving half. However, the real mother immediately offered to give up her claim to save the baby's life, demonstrating her true maternity. Solomon then declared her the rightful mother. Overall, possessing Solomonic judgment in addressing social challenges implies the capacity to make thoughtful, fair, and balanced decisions that promote harmony, justice, and the common good, even in situations where there may be competing interests or complex dynamics at play. The use of the "Trojan horse" metaphor instead typically alludes to a strategy where something initially presented as harmless or beneficial is used to gain access or acceptance, but it later reveals its true, often harmful, intentions or consequences. In fact, the concern may be that once engaged in GF investments, investors or institutions could face dilemmas when balancing environmental protection (such as reducing carbon emissions or conserving resources) with their economic prosperity goals (such as maximizing profits or growth). These goals can sometimes be at odds, as pursuing environmentally responsible practices can be costly or result in lower short-term financial returns. For this motivation, we structured the behavior of powerful and powerless agents in a very interesting way, letting the reader know that an iterative Delphi technique can also achieve scientific consensus through the aggregation of ideas from different subjects and the predisposition of the authors to make future predictions with an ethical stance. We have tried to achieve consensus step by step on our fabled theoretical basis through a repeated confidence in the independence of our opinions and on our presentation of the SMC examples in Table 1 on page 16.

Formally, if we have a set of models or strategies $\{(S_1, f_1), (S_2, f_2), \ldots, (S_n, f_n)\}$, where $S_i$ represents the $i$th model or strategy and $f_i$ represents its performance or predictive accuracy, then an efficient model can be mathematically expressed as:

$$(\mathrm{S}^*, f^*) = \mathrm{argmin}\{f_i(S_i) | S_i \; is \; a \; feasible \; model\} \quad (1)$$

where $\mathrm{S}^*$ represents the optimal or efficient model, $f^*$ represents its performance, and $argmin$ represents the argument that minimizes the function within its parentheses.

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In other words, an efficient model is the one that provides the best possible outcome or the highest level of predictive accuracy with respect to a given set of data **[6]** (Kaur & Rani, 2022). In the context of GF investments, the objective function $f_i$ represents the desired outcomes or benefits, such as environmental sustainability (ES) and economic prosperity, that investors seek to achieve through their investments. These objectives might include reducing carbon emissions, conserving resources, and generating financial returns. The feasible model ($S_i$) represents the set of investment options or strategies available to investors. Each option ($S_i$) has its own characteristics and trade-offs, including its environmental impact and potential financial returns. The optimization process seeks to find the most efficient or desirable investment strategy $(S^*, f^*)$ that minimizes certain costs or maximizes benefits, taking into account both environmental and economic factors.

*2.3. Inferences and Decisions by The side of Investors*

Often decisions can be quantified by determining the loss that would occur for each possible decision and for the various possible values of $\theta$. In the example of painkiller, the losses involved in deciding whether to advertise it or not would be complicated functions of $\theta_1$, $\theta_2$, and many other factors. This problem belongs to decision theory in that the ultimate goal is to decide whether or not to advertise a new pharmaceutical product (say, a painkiller), how much to advertise it, to what price to put it, etc. **[7]** (Limbu & Huhmann, 2022). A second source of non-sampling information that is useful to consider is called b) *prior information* **[8]** (Berndt, 2020). This is information about $\theta$ that arises from sources other than statistical surveys. Generally, previous information comes from experience regarding similar situations involving similar $\theta$. In the example of painkiller, for example, there is probably a lot of information available about $\theta_1$ and $\theta_2$ from different but similar pain relievers. Decision theory, as its name implies, is about the "problem of making decisions." Statistical decision theory is concerned with making decisions in the presence or else absence of statistical knowledge and could shed light on some of the uncertainties involved in the outcome of a decision **[9]** (Berger, 1989).

While for the most part we can determine the economic material culture by the resources are used, produced, even unused, and misallocated in economy at large, in our examples SMC is determined by material objects with no biased commissions or omissions which typically involve a failure in front of a rather abstract value: that is, keeping on with sustainability. It is difficult to identify material objects with no biased commissions or omissions when it comes to sustainability value. This is because every material object has some environmental or social impact associated with it, either during its production, use, or disposal **[10]** (ESMS, 2020).

However, some objects have a more positive environmental and social impact compared to others. Here are some examples of material objects that align with the sustainability value and have fewer biased commissions or omissions:

- Solar panels: Solar panels are an example of a sustainable material object that has a positive impact on the environment. They generate electricity from renewable energy sources, reduce the carbon footprint of households and businesses, and can lower energy costs.
- Electric vehicles: Electric vehicles (EVs) are another example of sustainable material objects that have a positive impact. EVs produce fewer greenhouse gas emissions compared to traditional combustion engine vehicles, and they rely on renewable energy for power, making them a more environmentally friendly transportation option.
- Reusable bags and containers: Reusable bags and containers are a sustainable alternative to single-use plastic bags and containers. By using reusable bags and containers, we reduce waste production, conserve natural resources, and reduce greenhouse gas emissions from manufacturing and transportation.
- Energy-efficient appliances: Energy-efficient appliances, such as refrigerators, washing machines, and air conditioners, reduce energy consumption and lower household utility bills. They also reduce greenhouse gas emissions from power generation and promote energy conservation.

 doi:10.20944/preprints202309.0956.v2



### 3. The Requests by the International Economic Agenda

We cannot trust we will exist for a long time or that our economic agenda will permanently ensure successful bonds **[11]** (Ozili, 2022). As expressed in [11] (Ozili, 2022) life span of products is becoming even feebler than this trust. Then, we should think of SMC as something could help to enlighten the link between economic growth and the environment, because a good pricing of GF instruments could be determinant in modeling techniques provide the best fit of economy with prospective sustainable goals. Proper pricing of GF instruments ensures that capital flows efficiently toward environmentally responsible projects and investments. This allocation of resources can drive innovations in sustainable technologies and practices. Well-priced GF instruments create financial incentives for businesses and individuals to adopt environmentally friendly practices. When the cost of capital is lower even for short-term sustainable projects, it encourages investment in areas such as renewable energy, energy efficiency, and conservation.

In reverse, social factors are essential in understanding the long-terminism of sustainability: both the environmental consumption and the growing social inequalities require a long-term orientation, and a shift of capital flows towards a more reliable and transparent corporate governance able to create jobs and spur innovation **[1]; p.3** (European Commission, 2018). Nowadays urgent issues such as the globalization of markets, cultures, and communities, or the aging of the populations, also make a priority the prediction of and the information on emergencies.

In their study, **[12]** (Vallance et al., 2011) introduce a tripartite definition of social sustainability as the

- "social sustainability's development" with its interests regarding inequality and poverty,
- "social sustainability's maintenance" which addresses the preservation of sociocultural practices and patterns in the context of economic and social change, and
- "social sustainability's intersection" which refers to behavioral adaptations to achieve biophysical environmental goals.

More recently, **[13]** (Chiu, 2004), equates social sustainability with ecological sustainability. This means that for an activity to be socially sustainable, it must maintain the current social structure, values and the like, since these constitute social limitations just as the environment contains ecological limitations.

Two key dimensions are at the heart of the notion of social sustainability such as 'social equity' with particular reference to access to opportunities and services, and 'community sustainability.' The first dimension is concerned with the notion of social justice, urging for the equitable distribution of resources in society in order to provide equitable access to local services, housing and jobs. In order to promote social equity, it is important to ensure that these resources are distributed equitably and that everyone has equal access to them.

For example, today, the COVID-19 pandemic has highlighted the importance of social equity in access to healthcare **[14]** (ILO, 2021). While the pandemic has affected people from all walks of life, it has disproportionately affected marginalized communities and low-income households who may not have access to adequate healthcare facilities or resources to protect themselves from the virus.

Another example of social equity concerns access to quality education. In many countries, access to education is still an issue, particularly for marginalized communities, those living in poverty, and those from minority groups. As a result, these communities may face limited access to opportunities and limited social mobility, reinforcing existing inequalities **[14]** (ILO, 2021). Community sustainability, on the other hand, is concerned with the long-term sustainability of local communities, including access to resources, services, and jobs. This principle recognizes that communities need to be sustainable over time and that environmental, social, and economic factors all play a role in achieving sustainable communities **[15]** (Thomsen, 2013).

The second concept is therefore related to the constant functioning and capacity of society as a collective entity. It goes without saying GF instruments must before of all harmonize and inevitably integrate with local tools and practices relevant to fostering inclusive green growth and large informal economies. "How can we assess the distinctions of standards that are important to be respected to achieve GF goals?" In this context, reference **[16]** (Cetina, 1999) introduced the term

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"negative knowledge," which describes i. our knowledge of the limits of knowledge, ii. the number of mistakes made in our ability to know, iii. the things that we infer without knowing, and iv. what people do not want to know.

As far as we know, the Green Bond Principles (GBPs) established by the International Capital Markets Association (ICMA) indicate i. renewable energy, ii. energy and resource efficiency, iii. pollution reduction, iv. water and waste management, conservation, and v. climate adaptation, "as the types of projects that can be financed with a green bond." **[17]** (Maltais & Nykvist, 2020). These concepts are based on the understanding that our material culture (MC) and consumption patterns have a significant impact on both economic growth and ES, and reflect the interconnectedness of economic, environmental, and social factors in the pursuit of sustainable development. Here negative knowledge acknowledges that there can be mistakes in our ability to predict the outcomes of GF instruments. For example, a financial incentive designed to promote environmentally friendly consumption patterns may not yield the expected results, and there could be unintended consequences or behavioral biases that we fail to account for. In addition, we often make inferences or assumptions about the effects of GF instruments on consumption patterns without having comprehensive data or a full understanding of all variables at play. For instance, we may assume that a tax on carbon emissions will reduce consumption of fossil fuels, but the actual behavioral response may be more complex. This encourages us i. to continually question assumptions, ii. be aware of potential errors in our thinking, and iii. confront uncomfortable truths about the challenges of aligning economic growth with environmental goals.

### *3.1. GF and Targeted Systems*

As it is intended for general systems, also GF systems can refer to a huge range of things in economics from the smallest public, private, and not-for-profit sectors to global sustainable development priorities such as the 17 SDGs (Sustainable Development Goals) determined by the 2030 Agenda for sustainable development (SD) as fine commitments to be achieved by 2030. The 17 SDGs and their 169 targets all highlighting development and sustainable urban management (SAM) are fundamental to people's quality of life **[18]; particularly p. 43** (United Nations, 1993). As stated by reference **[19]** (Miller, 1965), there are conceptual systems, concrete systems, and abstract systems, but—in any event, from the large or small, from the simpler to complex, from the concrete to abstract—all systems exhibit some properties such as "existence," "arbitrariness," and "demarcation."

The accomplishment of the 17 SDGs and their 169 targets requests "a broader view of what welfare entails, a longer-term view about the consequences of today's activities," and a "greater emphasis on international co-operation to reach viable solutions." **[20]; p.5** (OECD, 2001) The international system is answering someway to the requests of a green use of environments, products, and services by an enlarged number of populations, included the elderly, disabled, and children. For instance, a people-oriented approach is one that emphasizes social cohesion and inclusion, requiring to consider sustainable inequalities in access to resources. The United Nations has recognized the importance of sustainable development that is people-oriented and inclusive of different groups in society.

An approach that emphasizes social cohesion and inclusion and requires consideration of sustainable inequalities in access to resources is the concept of "Leaving no one behind" (LNOB). LNOB is a central theme of the above-mentioned United Nations' 2030 Agenda for SD, which recognizes the need i. to eradicate poverty, ii. reduce inequalities, and iii. protect the planet for all people, leaving no one behind. The LNOB approach recognizes that sustainable development cannot be achieved without addressing inequalities and promoting social inclusion and cohesion. One specific initiative that exemplifies the LNOB approach is the UNICEF Child-Friendly Cities (CFCI) and Communities initiative. This initiative aims to create inclusive, safe, and sustainable cities and communities for children and young people, by engaging with them and promoting their participation and inclusion in decision-making processes that affect their lives **[21]** (UNICEF, 2018). The initiative recognizes that sustainable development requires addressing the needs and rights of

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children and young people, and it promotes social cohesion and inclusion by ensuring their participation in shaping their communities. Below in **Figure 1** we see a tentative list of the many sectors and roles involved in sustainability.

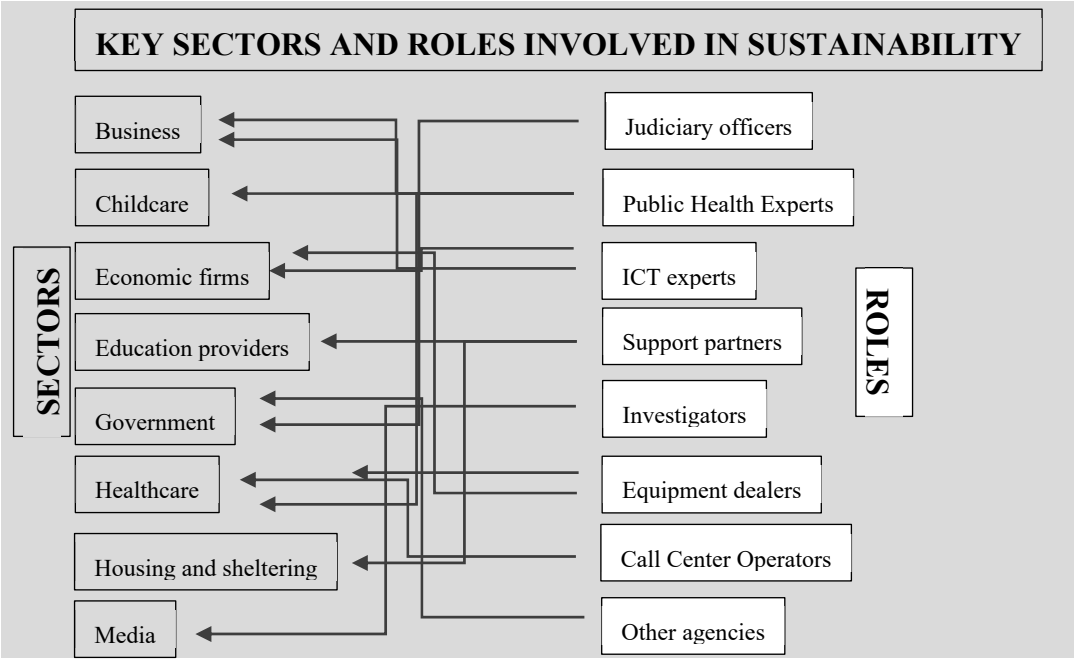


**Figure 1.** Sectors and roles involved in sustainability.

GPE is therefore currently integrating a) widespread digital technologies, b) global health protection measures, and c) the share of goods and liabilities. For the purposes of this article, it seems logical and suitable to define SMC through examples highlighting how humans often fail to diagnose, take decision-making, or plan in sustainability. This means also that investments in (i) forest restoration, (ii) smallholder production, and (iii) green infrastructure could encounter the lack of knowledgeability of the correct Green Growth practices often take for sure into account the economic, social, cultural and geographical features of regions.

As in the case of the challenge to reduce green-house gases' emissions to zero, the social dimension of sustainable development asks that the more and more necessary conventions and treaties on environmental topics take advantage of an extensive network of sectors and roles be embedded into a complex net of i. ethically responsible organizations, ii. supraordinate spheres of technological expertise, and iii. institutional commitment criteria. It is in fact possible to fund bonds and especially loans at GF through a net of innovative financial actors and role models not eligible for traditional bank credit, such as non-profit associations, non-governmental organizations (NGOs), local businesses, private individuals, and even charitable organizations **[22]; pp. 725–26** (Dörry et al., 2018).

We therefore will try to consider investments that enhance the 'green' and 'clean' at the same time, such as ',green bonds,' and 'green insurance.'

Topics involved in such kinds of investments may include i. renewable energy, ii. mass transportation, iii. sustainable water, iv. air pollution, and v. waste management, and they often go through a specific process in order to be qualified for a green label. This means these financial products must pass inevitably by a complex infrastructure of taxonomies, standards, and certification, useful:

a. to check the issuers awareness and capacity to manage environmental issues,
b. to instill oversight and management from investors and other stakeholders, and
c. to make climate and green issues investable.

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*3.2. The due Diligence in Investments*

When a project is qualified for a green label, it means it meets specific environmental and social criteria and is aligned with internationally recognized standards and guidelines for sustainable finance. The green label provides a transparent and credible way to verify the environmental performance of an investment, making it more attractive to socially responsible investors and potential lenders. By providing a recognizable and trustworthy standard for sustainable finance, the green label can help build public trust in financial institutions and promote wider social acceptance and support for sustainable finance objectives and targets. It can also help to increase accountability and encourage financial institutions to be more responsible and transparent in their investment decisions and environmental impacts.

The green label is therefore a way of measuring social consent around financial objectives and targets by demonstrating that investments and financial products align with environmentally sustainable and socially responsible goals. It serves as a tool for promoting greater sustainability in finance and addressing environmental and social challenges while meeting the needs of investors and financial institutions.

Overall, GF investments can be a powerful tool to steer investments towards sustainability and help address the urgent environmental challenges we currently face. By promoting investments in sectors like renewable energy, sustainable transportation, water management, waste management and other green sectors, GF can contribute to mitigating climate change, reducing energy consumption, and promoting a more sustainable and resilient economy.

The sustainability conditions may be violated, as in the practice of "greenwashing," that is the practice to attach the label of green to a project "does not have any environmental value to begin with or it could lose its environmental benefits due to poor execution or unforeseen circumstances." **[23]; p.7** (Schmittmann, 2021). The consideration of the above macro examples in relation to international systems' answers to sustainability is important as it is hardly deniable that the use of special GF instruments such as a) the taking into account the ESG factors of an economic or project activity, b) its inclusivity along all dimensions relevant to achieving green needs **[24]** (Ozili, 2022), and c) the exaptation of ethics to obtain CSR (corporate social responsibility), allows for an ambitious perspective may introduce also large facets of unsustainability into their implementation proceedings.

Some of the potential challenges associated with the implementation of GF instruments include:

- *Lack of standardized ESG metrics and reporting*: There is currently no standardized metric for measuring ESG factors, which can lead to confusion and inconsistency in reporting. This can make it difficult for investors to accurately evaluate the sustainability of different investments.
- *Inclusivity challenges*: GF instruments may face inclusivity challenges in terms of who is included and excluded from investment opportunities. This can occur if certain groups or individuals are disadvantaged by the criteria used to evaluate investment opportunities.
- *Risk of greenwashing*: GF instruments may be susceptible to "greenwashing," where investments are advertised as sustainable but may not be fully aligned with sustainability goals.

Our method will be depersonalized and unemotional with no 'condemnation' of GF coming from bad groups, if any. Not all green bond issuers can in fact be insurers or paladins of sustainability, though in their financial products there is at least a signal they mean to meet sustainable goals using such instruments **[25]** (Bhattacharya, 2021).

Last but not least, the initiatives for finding the most effective policy framework to support long-term financing, diversification of financial intermediation, and encouragement investment in long-term GF assets have often been challenged by prudential performance evaluations such as ESIAs (Environmental and Social Impact Assessments) and ESMPs (Environmental and Social Management Plans). Our method is then focused mainly on choices—how individuals, governments and businesses make them, and which SMC may arise from—considering also the evaluation of alternatives and the varying degrees of capital accumulation necessary to GF instruments.

 doi:10.20944/preprints202309.0956.v2



**4. Degradation and Restoration as Key Targets**

At a global level, ecological changes, land degradation, and food insecurity have led to disputes over resources and competition for access to natural resources **[26]** (Muluneh, 2021). This competition has created tension and increased instability, particularly in regions where resources are scarce. The legitimacy of resource levels' differences has also been challenged, as wealthier countries and individuals have access to more resources and are better able to respond to environmental and economic challenges, while poorer countries and individuals often lack the resources and capacity to respond effectively **[27]** (Tuihedur Rahman et al., 2019). Malnutrition and disease outbreaks have been increasingly read as the expression of an underlying natural-resource stress disorder, as well as of a likely scenario for conflicts and institutional inefficiency. Which resources' levels legitimacy is to be previewed in relation to population strata are both powerful and unpowerful? How to manage a "public utility of governance," is often grounded on legitimacy beliefs are likely to be associated with "self-interested calculations"? **[28]** (Dellmuth and Schlipphak, 2020).

This certainly requires a multifaceted approach that addresses the complex interplay between economic, social, and environmental factors.

A) One approach is to promote transparency and accountability in GF by establishing clear and standardized criteria for sustainable investments and ensuring that financial institutions are held responsible for meeting these criteria. This may involve setting up regulatory frameworks that require financial institutions to report on their environmental and social impacts and implementing penalties for non-compliance.

B) Another approach is to engage stakeholders in the GF decision-making process, including local communities, civil society organizations, and other actors with a stake in sustainable development. This can help to ensure that investments are aligned with local priorities and needs, and that social and environmental concerns are taken into account in the decision-making process.

C) Educating the public about the benefits of GF, such as lower carbon emissions, improved environmental quality, and increased job creation, can also help to build public support and legitimacy for sustainable finance objectives and targets. This may involve targeted communications campaigns, public awareness programs, and community engagement initiatives.

D) Finally, incorporating GF considerations into broader economic policy frameworks, such as the SDGs and the Paris Climate Agreement, can help to reinforce the legitimacy of sustainable finance objectives and ensure that they are integrated into broader development agendas.

For example, specifically in SD Goal 11, the policy framework is "to make cities inclusive, safe, resilient and sustainable." This means growth and innovation in urban areas have systematically to consider vulnerable urban areas and critical infrastructures threatened by geohazards, as well as prompt cooperation and awareness on environmental matters in cities. Since early 2020 the COVID-19 pandemic has reinforced the need for a more sustainable economy at the global level. Many of the underlying causes that made the pandemic possible, such as wildlife trade, deforestation, and climate change, are also drivers of environmental degradation and unsustainable resource use. This has increased awareness of the need for systemic change and a more sustainable and resilient approach to economic growth.

Secondly, the pandemic has had significant social and economic impacts that have exposed existing vulnerabilities and inequalities in societies and reinforced the need for a more equitable and sustainable economy. The pandemic has disproportionately affected vulnerable communities, such as low-income households, indigenous communities, and people with disabilities, and has highlighted the importance of social inclusion and cohesion in building a more sustainable and resilient future.

This way GF instruments have probably become a subset of financial sustainability's search to mobilize private capital flows in green entrepreneurial suits to be able to face CT and the prospective environment protection/restoration. Financial institutions and investors are becoming more aware of the financial risks associated with climate change. This includes physical risks (e.g., extreme weather events) and transition risks (e.g., policy changes and market shifts). GF instruments provide a way to mitigate these risks by investing in environmentally sustainable projects and businesses. They align

 doi:10.20944/preprints202309.0956.v2



with i. the growing recognition of the economic opportunities associated with sustainability, ii. the need to mitigate climate-related financial risks, and iii. the increasing demand from both consumers and regulators for sustainable financial practices. Governments and regulatory bodies worldwide are introducing policies and incentives to encourage green investments and sustainable financial practices. This includes measures such as tax incentives, carbon pricing, and reporting requirements that promote the integration of environmental considerations into financial decision-making.

*4.1. In the Search of an Ethically Responsible Decision-Making*

One principle of decision-making in GF investments is that the actors build their problems not from "real problems" but from a mixture of the systematically recognized characteristics of "the space of problems." We then cannot always multiply together the two relevant marginal probabilities at a) SMC examples in country $X$, and b) failures in diagnose, take decision-making, or plan in GF in country $Y$, because there is not statistical independence, and the joint probabilities cannot be easily obtained. When we are dealing with complex systems such as GF, the interactions between different factors can be intertwined, leading to complex feedback mechanisms and dependencies. The failure of the GF system may be influenced by a range of factors, including economic factors, social factors, environmental factors, and political factors **[29]** (Gan & Voda, 2023). These factors could either reinforce or counteract the effects of GF investments in the world.

This lack of statistical independence presents a challenge for green sustainable decision-making. It means that traditional statistical methods may not be effective in predicting the outcomes of GF investments, and more sophisticated analytical methods that take into account the interactions between multiple factors may be required. To make green sustainable decisions that will have a long-lasting impact, we need to consider the complexity of the system and recognize that different factors are interconnected. We need to engage diverse stakeholders, including local communities, in the decision-making process and consider social, economic, and environmental factors in a holistic and integrated way. This implies that decision-makers need to adopt a flexible and adaptive approach, adjust to changing circumstances, and continually assess the impact of GF investments to ensure they are achieving their intended results.

This seemingly trivial observation is of central significance if we think that 'old wine in new bottles' method when facing GF investments may disguise the perception of social control measures are set forth, solved, a/o mitigated by a participatory approach. In this procedure, such problems might not be "real enough" for the actors but only "realistic", with the consequence that already in the analysis of the conditions of the possibility of observing [the actors may] enter a problem that is repeated in the analysis of their decisions. GF finance can be considered a second-third generation of finance, succeeding the first which was mainly grounded on '"rational" wants—restricted to the utilitarian benefits of high returns and low risk.' **[30]** (Statman, 2019). In second-third generation of finance the evaluation of ethically responsible decision-making, embedded into supraordinate spheres of technological expertise, and sponsored probably by institutional commitment criteria, poses big questions to a participatory approach on individual decision-making. While individual investors and consumers have a role to play in promoting sustainable finance, there are significant challenges to ensuring that their decisions align with broader societal and environmental goals.

For example, individuals may lack the expertise and information required to make informed decisions about sustainable finance, making it difficult for them to evaluate the environmental or social impact of different financial products or instruments. This is particularly true for more complex financial products, such as derivatives or structured financial products, which require extensive technical knowledge to understand. Furthermore, while individual decision-making is important, there is a need for supraordinate spheres of technological expertise and institutional commitment criteria to guide decision-making and ensure that the financial goals align with broader societal and environmental goals. These parameters are interrelated and can impact the design, performance, and outcomes of GF products.

For example, GF issuers may consider parameters such as saving and spending in developing investment products that promote sustainability. They may design products that incentivize

 doi:10.20944/preprints202309.0956.v2



sustainable behavior by offering higher returns on eco-friendly investments or lower fees on sustainable financial products. Reference **[31]; p.3** (AFI, 2021) makes appeal to an IGF (Inclusive Green Finance) to deliver "lower operating cost" to MSMEs (Micro, Small and Medium Enterprises) and low-income households have not the necessary upfront to invest in low-carbon technology. Portfolio construction is another key parameter in GF product design, where issuers may seek to create diversified portfolios that include sustainable investments alongside traditional investments. This can help mitigate risk while also promoting sustainability in the investment mix. As an example, a GF fund may include investments in renewable energy, green infrastructure, and sustainable agriculture, alongside traditional investments such as bonds and stocks. Asset pricing is another important parameter in GF product design, where issuers may need to adjust asset pricing to reflect the additional risks and benefits associated with sustainable investing.

### *4.2. Contract Theory and GF*

The financial services industry's interconnectedness has created a myriad of agency relationships in which monitoring is difficult, and many of these relationships involve risk transfer or risk sharing within groups. Consequently, ethical standards within the field must be high, lest the power of participants' own incentives drive them to act counter to their fiduciary duty to their clients **[32]** (Shah, 2014). As expressed by reference **[33]** (Maltais & Nykvist, 2020) The overall impression is that "companies seek out and can secure customer demand and loyalty by demonstrating the integration of sustainability into their business practices," while to incorporate sustainability into the strategic decisions of the company's leadership is not always feasible or better the lower yields from green bonds bring into question the investors' ability to invest in this asset class **[33]; especially pp. 10–12** (Maltais & Nykvist, 2020).

#### 4.2.1. The "Principal-Agent" Problem in GF

Other than enabling investments in a green transition (GT) that reduces carbon emissions and biodiversity loss while providing public services like education and health, as well as job opportunities for social mobility, ESG factors embedded into economies require ethical standards in relation to i. human rights, ii. labour and industrial relations, iii. anti-corruption, and iv. the protection of consumer interests. As referenced in **[34]; p.10** (Schmittmann & Chua, 2021) « […] sustainable and green debt instruments are conventional debt plus a promise by the issuer to use the proceeds from the debt for an earmarked purpose (activity-based) or a sustainable performance target that affects the interest rate (issuer-based). » In addition, a sustainable economic growth in response to the debt crisis asks with priority, investors can assess and compare behaviors of issuers when making investments' programs. Since the financial intermediation chain is constituted of shareholders, asset managers, financial intermediaries, and end investors—all representing dense networks are not easy to be framed, guided, and tracked— it is made up of subsets or categories may have different ethical considerations and perspectives. This can result in conflicts of interest and ethical independence among the different actors in the chain.

For example, shareholders may prioritize maximizing returns on investments, while end investors may prioritize social and ES. Asset managers and financial intermediaries may be caught between these two opposing priorities, leading to decisions that do not fully align with either goal. In such cases, ethical conflicts can arise, and issues of loyalty may also arise. For example, an asset manager may be more loyal to the interests of shareholders than to the interests of end investors or vice versa, and this may influence their decision-making.

However, non-financial disclosures, such as improved positioning and reputation, can also play a role in the financial intermediary chain. Financial intermediaries may use non-financial disclosures as a way to mitigate ethical conflicts and improve their market position. For example, asset managers may choose to disclose their investments' ESG performance, or financial intermediaries may disclose their efforts to promote social and ES. These disclosures can help to enhance their reputation and differentiate themselves from competitors who may not have a similar commitment to sustainability.

 doi:10.20944/preprints202309.0956.v2



Overall, the financial intermediation chain can present ethical challenges due to competing priorities, conflicts of interest, and loyalty concerns. Then, its best ethical insurance is granted from:

- the independence of each subset or category, may be essentially unloyalty to each other in front of an increasing perceived risk, and
- the chance of compensation through non-financial disclosures, such as an improved positioning and reputation as well as other benefits are not disclosed in monetary form.

So doing, debt's lack of transparency could increase distrust and gridlock as creditors would fear that any debt restructuring might only benefit the nontrasparent creditors rather than the reliable guarantees to restructure current debt or issue new debt **[35]** (Yue & Nedopil, 2022). As a matter of fact, it has been noticed that studies lack to inquiry "investors' motives for engagement in green debt." **[34]; p.12** (Schmittmann & Chua, 2021). This lack of trust can result in a lack of investment and reduced funding for sustainable initiatives. If creditors do not have confidence in the transparency and reliability of debt financing, they may be less likely to invest in sustainable projects, leading to a lack of funding for initiatives aimed at promoting sustainability goals.

GF instruments can provide a solution to this issue by promoting greater transparency and accountability in debt financing. GF instruments are designed to direct resources towards sustainable projects while also ensuring transparency and accountability in the use of these resources. By providing clear and transparent information on the use of GF funds, investors and creditors can have greater confidence in the reliability of these financing mechanisms.

For example, GF instruments such as green bonds and sustainability-linked loans provide transparency on the use of funds and the performance of the underlying projects. This enables investors to track the impact of their investments and ensure that the funds are being used in a way that aligns with their sustainability goals. Therefore, promoting transparency and accountability in debt financing through GF instruments can help to promote trust among creditors and investors, increasing funding for sustainable initiatives and promoting progress towards a more sustainable future.

Both ESG funds and green bonds tend to undergo large price corrections after an initial investment boom. Reference **[36]** (Aramonte & Zabai, 2021), recalls the initial investment boom at railroad stocks in the mid-1800s, internet stocks during the dotcom bubble and mortgage-backed securities (MBS) in the Great Financial Crisis (GFC), which are cases suggest to closely monitor developments in the ESG market, especially from the point of view of "the financial risk that might arise from a shift in investors' portfolios."

Then, in theory also GF products may face several types of risks, such as credit risks, market risks, and operational risks. Risk management indicators, such as i. capital adequacy ratio, ii. non-performing loan ratio, iii. loan to deposit ratio, iv. debt to equity ratio, v. total debt ratio, and vi. return on risk-adjusted capital, recall the strategies used in banks and financial institutions to manage risks "include risk transfer, risk avoidance, mitigation of negative risk effects, and acceptance of some or all of the consequences of a particular risk." **[37]; p.15** (Nasratullah, 2021). As referenced in **[38]; p.280** (Jirásková, 2017), this management entails also the arising of:

- Collusion risks,
- Risks resulting from conflicts of interests,
- Fraud risks,
- Secondary risks, and
- Residual risks.

Another challenge from a macro perspective is the greater complexity of sovereign liabilities, where creditors include a larger share of commercial and nontraditional lenders. In countries considered particularly vulnerable to the global economic crisis and then eligible under the debt service suspension initiative (DSSI) have been for example issued new solutions for debt restructuring, such as debt-for-nature-swaps **[35]** (Yue & Nedopil, 2022). As a matter of fact, creditors and debtors should explore and accelerate innovative and unconventional solutions to swap portions of debt would most likely never paid back to be used for environmental purposes (such an example, debt for nature-swaps), health-related purposes (such an example, debt-for-health swaps), or broader

 doi:10.20944/preprints202309.0956.v2



targets (such an example, debt for SDG swaps) **[35]** (Yue & Nedopil, 2022). Debt-for nature swaps, debt-for-health swaps, and debt-for-SDG swaps are examples of innovative solutions that can help to address sustainability challenges and reduce the burden of debt. In these types of swaps, creditors would forgive a portion of the debt owed by the debtor in exchange for some form of social or environmental benefit. For example, in a debt-for-nature swap, creditors could forgive a portion of the debt owed by a developing country in exchange for the country protecting or restoring a specific natural habitat or ecosystem.

*4.3. Targeted Refinancing Operations and Long-Terminism*

The Sustainability Linked Loan Principles (SLLP) provide guidelines for improving "the borrower's sustainability profile by aligning loan terms to the borrower's performance against the relevant predetermined SPTs" (sustainability performance targets), and in so doing they incentivize borrowers to make improvements to their sustainability profile over the term of the loan **[39]** (LMA, 2019). The Sustainability Linked Loan Principles (SLLP) provide a framework for lenders and borrowers to align loan terms with sustainability performance targets (SPTs). The main economic features of the SLLP are:

- Flexibility: The SLLP allows for flexibility in defining sustainability performance targets, which can be customized to the borrower's specific industry, operations, and sustainability goals.
- Sustainability-linked pricing: The SLLP enables sustainability-linked pricing, which links the borrower's interest rate to their performance against predetermined SPTs. This incentivizes borrowers to improve their sustainability performance over time, as the better they perform, the lower their interest rate will be.
- Documentation and disclosure: The SLLP requires clear documentation and disclosure of the sustainability performance targets, the relationship between these targets and the loan terms, and the data used to track progress toward these targets.

Finally, in response to the Covid crisis, central banks in various jurisdictions implemented "funding for lending" (FFL) programs, which allow banks to access low-cost funding in order to lend to businesses in need. This type of measure had been introduced previously, such as by the Bank of England and the Magyar Nemzeti Bank in response to the euro area crisis in 2012 **[40]** (Casanova et al., 2021). In 2020, several additional jurisdictions implemented similar programmes (including Australia, Mexico, New Zealand, Saudi Arabia, Sweden, Switzerland and Taiwan). Likewise, the European Central Bank (ECB) initiated the third phase of its Targeted Long-Term Refinancing Operations (TLTRO III), which aims to incentivize lending to households and corporations by providing low-cost financing to banks **[40]** (Casanova et al., 2021). Some examples of FFL programs are:

- Bank of England's Funding for Lending Scheme (FLS): The FLS was launched in 2012 to provide low-cost funding to banks and building societies in the UK. The program allowed banks to borrow from the Bank of England at a low interest rate, with the condition that they pass on the benefits to businesses and individuals through lower interest rates for loans and mortgages.
- European Central Bank's Targeted Longer-Term Refinancing Operations (TLTROs): The TLTROs were launched in 2014 to provide low-cost funding to banks in the eurozone. The program allowed banks to borrow from the European Central Bank at a low interest rate, with the condition that they use the funds to lend to businesses and households.
- Japan's "Quantitative and Qualitative Monetary Easing" (QQE) program: The QQE program, launched in 2013 by the Bank of Japan, offers low-interest loans to banks to encourage them to lend more to businesses and support economic growth **[41]** (Kuroda, 2017).
- India's "Priority Sector Lending" (PSL) program: The PSL program requires banks to lend a certain percentage of their loans to priority sectors such as agriculture, education, and health care. This program provides low-cost funding to banks for PSL loans, encouraging them to support these priority sectors **[42]** (Panda SK et al., 2017).
- Canada's "Business Credit Availability Program" (BCAP): The BCAP was launched in response to the COVID-19 pandemic to provide financing to businesses struggling during the crisis. This

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program provides low-cost funding to banks and credit unions to help them offer loans to businesses in need **[43]** (BDC, 2020).

- Brazil's "Productive Development Credit" (PDC) program: The PDC program, launched in 2008, provides low-interest loans to Brazilian companies for investment.

We consider below in **Table 1** examples of consistent implementing of GF instruments, where SMC objects are key to foresee which actors will be more likely and enduring to face with the above-mentioned challenges to a sustainable future.

**Table 1.** Ten examples of consistent GF (Green Finance) instruments.

| Implication | SMC object | SMC area | SMC case |
|---|---|---|---|
| Monetary | Paid family leave | Labour market | California's Paid Family Leave Program (PFL) |
| Non-monetary | Shorter/flexible work-time arrangements | Labour market | Sweden's six-hour workday experiment |
| Monetary | Extension of contributory social security schemes | Labour market | Brazil's expansion of the Cadastro Unico (Unified Registry) |
| Non-monetary | Incentivizing specific skills education programmes | Education | Germany's Federal Environmental Education Program (FEEP) |
| Non-monetary | Improvements in conservation and protection of biodiversity | Agriculture | Global Environment Facility (GEF) |
| Non-monetary | Improvements in sourcing/producing quality products | Transportation | Green Financing Framework of the European Investment Bank (EIB) |
| Non-monetary | Advancement in integrity, transparency, and professionalism | Business ethics | The United Nations Principle for Responsible Investment (PRI) |
| Non-monetary | Provision of health and safety standards for employees and volunteers | Labour market | Fair Wear Foundation (FWF) |
| Monetary | Reallocation of public expenditures | Social Protection | Addis Ababa Action Agenda |

## 5. Conclusions

The adoption of GF instruments can also have a transformative impact on traditional financial institutions, promoting the integration of ESG considerations into investment decision-making, and driving capital towards sustainable and socially responsible projects.

Overall, GF can be considered as a system that can transform local/regional economies in a worldwide scale of economic evaluations, by promoting the sustainable use of resources, strengthening local communities, and fostering economic development that prioritizes social and ES. Risks have been strengthened enough as the benchmark against which a non-financial comparability framework embedded into classical economic logics challenges market standards and taxonomies at GF. Some of these new forms include:

- Collaborative networks: GF instruments can benefit from collaborative networks that bring together diverse stakeholders, including investors, businesses, policymakers, and civil society organizations. Collaborative networks can facilitate knowledge-sharing, innovation, and capacity building, and can encourage responsible investment practices.
- Sustainable product design: Sustainable product design involves strategies that minimize environmental impacts, reduce waste, and promote the circular economy. Designing products in a way that considers the entire lifecycle of the product can reduce environmental footprints and support responsible consumption.
- Sustainable production processes: Sustainable production processes prioritize resource efficiency, reduce harmful emissions, and minimize waste. Implementing sustainable production processes can result in cost savings, increased efficiency, and reduced environmental impact.
- Ethical distribution: Ethical distribution involves strategies that prioritize social responsibility, supply chain traceability, and fair labor practices. Creating transparent supply chains that ensure responsible sourcing and production can contribute to a more sustainable future.

The potential future directions for sustainable finance in Europe and elsewhere include:

- Integration of ESG factors: A continued emphasis on integrating environmental, social, and governance (ESG) factors into investment decision-making and portfolio management will likely continue in the future. This could include the development of common ESG standards and metrics to promote greater comparability and transparency across different financial instruments.
- Climate risk assessment: The assessment of climate risks will become increasingly important in the future as investors seek to manage their exposure to the physical and transitional risks of climate change. This could lead to increased demand for green bonds, climate-related financial instruments, and climate risk data and analytics.
- Green taxonomy and labeling: The development of a green taxonomy and labeling system will be important for scaling up GF instruments and promoting more sustainable investment practices. Efforts to standardize definitions of what activities can be considered "green" will be critical to prevent "greenwashing" and ensure accurate classification of sustainable investments.
- Regulation and reporting: Continued focus on regulation and reporting requirements to promote transparency and ensure compliance with ESG goals.

The new forms of organization, cooperation, product design, production processes, and ways of distribution are a prerequisite to such novelty and successful outcomes have been expressed by the ten SMC examples we have highlighted along our paper. When SMC is examined in relative isolation, its apparent simplicity is transformed into complexity, and the matters encountered become so involved that it is even difficult to indicate clearly what is meant by SMC. Then, we have highlighted a) the low probabilities to intercept SMC objects require large amounts of data in order to get significant statistics for SMC to emerge as a field discipline, b) the data collection that concentrates on recording SMC examples rather than on its producers and customers, and c) the decision-making in GF shows finally we are often unprepared to keep on with sustainability.

**Author Contributions:** Conceptualization: R.F.; literature review: R.F.; hypothesis development: R.F.; data collection and data sorting: R.F., S.C., P.A. and F.R.; hypothesis evaluation: R.F.; discussion: R.F.; reviewing: R.F., S.C., P.A. and F.R. All authors have read and agreed to the published version of the manuscript.

**Funding:** This research received no external funding.

**Conflicts of Interest:** The authors declare no conflict of interest.

## Abbreviations

CFCI (Child-Friendly Cities); CT (climate transformation); ES (Environmental Sustainability); ESIAs (Environmental and Social Impact Assessments); ESMPs (Environmental and Social Management Plans); FEEP (Federal Environmental Education Programme); FSC (Forest Stewardship Council); FWF (Fair Wear Foundation); GEF (Global environment Facility); IF (innovation finance); IGF (Inclusive Green Finance); GPE (Green Participatory Economy); LNOB (Leaving No One Behind); PRI (Principles for Responsible Investment); SMC (Sustainable Material Culture); Ss (Sustainability score).

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