

Insurance business and social sustainability: A proposal^{*,**}

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ABSTRACT

Sustainability issues are emerging as a major focus for the insurance institutions, who have to face a number of challenges of the immediate future regarding environmental, social and governance (ESG) factors, climate changes, and catastrophic events. Despite this, literature is still scarce. In this vein, our work contributes to the small but growing body of literature on sustainable finance insurances, by providing evidence of the positive role that insurance companies can play in realizing a more sustainable financial system. The study proposes an innovative securitized process, described as a financial cycle oriented to the achievement of the social objective of collective health. Sustainable instruments allow firms, insurance companies and investors to play a proactive role: virtuous companies, attentive to health protection of their employees, could benefit from premium discounts on the costs of insurance coverage for business risks. The analysis demonstrates how the securitization scheme supports projects with economic-social impact, underlining main actors' roles, challenges, and opportunities for a sustainable future. Findings pave the way for designing new sustainable insurance solutions and have both practical and social implications.

1. Introduction

In recent years, some scholars have called for the reconsideration of finance theory [1,2], rebuilding new improved approaches in finance, and a much deeper reorientation of finance research. The financial crisis of 2007 pointed out the limitations and failures of the neoclassical finance, favoring the emergence of post-crisis finance networks and movements. New visions are explored, moving beyond neoclassical paradigm [3], harmonizing the aspects of profit, prosperity, people and planet, considered the basis on which the building of a good society rests [4,5].

Paris Agreement (2015) and Agenda 2030 set out climate and development goals (Sustainable Development Goals - SDGs), by indicating the guidelines for sustainable developments. In recent years, a number of governments, institutions, companies, and individuals are engaging in sustainable activities aimed at realizing the SDGs-Agenda 2030, and also experimenting sustainable business models, social

inclusion practices, collaborative partnerships and sustainable welfare schemes. In the last two decades, the ESG movement has grown from a corporate social responsibility initiative into a global phenomenon that is reshaping the broader business landscape. In this vein, many innovative responses to the sustainability challenges are revealed, in theory and practice, by new approaches such as alternative finance, impact investing, responsible finance, and ecological finance. Nevertheless, research on these issues is still in its early stages and requires further investigation. Many other aspects related to the relationship between ESG factors, sustainability and financial systems need further analysis and closer examination.

On the practical level, financial intermediaries are experiencing quite a number of sustainable strategies and practices, with the aim of integrating ESG factors into investment decisions, measuring and managing ESG risks and opportunities, and developing innovative sustainable business models. As noted by Pfeifer and Langer [6] climate change and ESG issues have strongly influenced the finance sector – both

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banking and insurance – worldwide in the last decades, accompanied by legal directives, particularly in Europe.

When focusing on insurance companies, it is worth noting that the insurance sector is an integral and highly interconnected part of the financial system, in turn, interconnected with the production system and Earth System, in the Anthropocene context [7]. Therefore, sustainability themes have reached the insurance sector in different ways, hence it is necessary to consider the effects of sustainability risks and opportunities both on the asset and liability side of insurers. In particular, financial insurance for extreme events can play an important role in hedging against the implication of climate change [8] or against catastrophic risks [9]. Extreme weather events and natural catastrophes are considered the most relevant sources of risk, in terms both of likelihood and of impact (World Economic Forum, 2019 [9]). Thus, it is not surprising that the climate change aspects have been the dominant aspects in managing sustainability risks and opportunities [6], and that there is abundant literature on insurance against extreme weather events and the role of insurance tools [10]. Nevertheless, on the practical level, it has been stated that *“the combination of the increasing frequency and severity of natural catastrophes and the limited capacity of (re)insurance markets creates a challenging market environment for the (re)insurance industry. (...) Given that the theoretical literature assigns a high value to protection against natural catastrophes, it is no surprise that in the 1990's, the limited capacity of the reinsurance market was one of the central causes leading to the invention of catastrophe bonds”* ([9], p. 2).

These considerations highlight the importance of the insurance sector in sustainability paths [11], as well as the importance of conducting further analyses on sustainable insurance instruments, useful in offering solutions to environmental and social complexity. This is even more true when considering the recent challenges posed to financial systems by the pandemic (such as the Covid-19) and the war in Europe. The pandemic can be considered one of the cases of extraordinary catastrophes and represents a major challenge for the insurance and the re-insurance industry, as well as the risk securitization funded by the issuance of catastrophe (CAT) bonds [12]. Likewise, the impact of the war on global food and energy prices poses several challenges to insurance companies.

Just recently, The Geneva Association [13] underlined that businesses (including the insurance industry) also under the influence of these events will have to pay more attention to the ‘S’ dimension of the ESG factors, characterized by a high degree of multifacetedness. More in detail, the Geneva Association [13], p. 6) stated that the ‘S’ agenda is inherent in the core business of insurance, because of it provides societies with financial security and the ability to withstand and bounce back from shocks: *“This is particularly relevant for the insurance industry, which is widely recognized as inherently socially beneficial. Insurers make positive contributions to social sustainability, defined as the capacity of current and future generations to live and work in healthy and liveable conditions that promote diversity and equal opportunities. These contributions primarily arise from insurers’ core business (‘business as usual’), such as providing access to risk protection, incentivising risk prevention and investing funds for the long run”*.

Viewed from this angle, the role of the insurance sector appears even more relevant in sustainable transition, because of its peculiarities in facing overall economic, environmental, and social facets of SDGs formulated by the UN. Despite growing attention by industry leaders and regulators, literature on ESG practices in insurance companies is still scarce [14].

Moving from these considerations, this work contributes to the growing body of literature on sustainable insurance, by providing evidence of the positive role that insurance companies can play in realizing a more sustainable financial system.

In more detail, the study proposes a securitized scheme: whoever buys it is counting on the good trend of the pandemic and is therefore stimulated to observe the rules of good health conduct. The study deals with this problem for the first time within a specific ESG-framework,

presenting the securitization of the pandemic risk as a useful tool to realize a virtuous cycle. The securitization of the pandemic risk seems to have all the credentials to be an effective tool both for managing pandemic risks and investing in sustainability. The new securitized process is described, within a financial cycle oriented towards achieving the social objective of collective health. The contractual profiles are formalized and deepened, in the light of past securitization experiences in the insurance sector. The dynamics of the virtuous cycle related to product risk sharing, as well as the role of all actors involved in it, are detailed. A numerical example considers a securitized pandemic bond, whose cash flows are linked to the expected number of infected and the realized number of them during a specific time interval.

The remainder of the article is structured as follows. The second section presents the state of the art with respect to securitization in the insurance industry, with basic bibliographic references on derivatives already existing in similar contexts, highlighting the challenges of the pandemic in a world more and more sensitive to sustainability, with regard to contributions in scientific literature and to an insurance business increasingly called to social responsibility. The third section focuses on possible responses in a sustainable way for insurance businesses to meet the challenges. In the fourth section a simple, new securitized scheme - that constitutes the proposal of the paper - is presented and described framed in a financial cycle oriented to the achievement of the social objective of collective health. The fifth section defines and analyses the actuarial contract structure. The sixth section is devoted to the results obtained and the comments derived from them. Section 7 deals with the opportunities and the factors of success according to the actors’ and stakeholders’ point of view. Some macro-economic considerations are provided. The final section brings together conclusions and discusses future developments and opportunities drawing on main results. Finally, the Appendix outlines the theoretical model that seems particularly suitable to solve the problem of pricing this product.

2. Securitization and insurance sector: lessons from past experiences and emerging issues

The use of the securitization tool in the insurance field has as its primary objective the transfer of risks from the insurance sector to the capital market. This not only has an advantage of a strictly financial nature, but also reduces the impact of the rigidity of the regulations on compulsory reserves.

From an insurer’s point of view, locking up capital in reserves is a guarantee of solvency, but at the same time constitutes a limitation on the financial availability for business expansion and product innovations. The possibility of freely using a larger amount of capital for these purposes has historically been one of the driving forces behind the increased interest of operators in these new risk transfer alternatives.

On the other hand, those to whom the security is addressed may be numerous investors and, in this way, even very large risks can be adequately controlled. Quite differently from a share, which exposes the shareholder to all the risks impacting on the entire business, a linked security, even though it is burdened with a well-identified specific risk, if held within portfolios, will contribute to an efficient diversification effect. But the aspect we wish to emphasize is that a linked security, in a much more pronounced way than other financial instruments, can capture the preferences of the investor and this aspect is important in order to intercept his/her growing sensitivity to sustainable issues. In a securitization system, the dual objective of increasing both the reputational value of the insurer and the satisfaction of investors sensitive to issues related to the broad category of sustainability is realized.

Among these issues, current events have brought us face to face with the health risk, which has become a collective risk on a par with the risk linked to climate change or to pollution and so on. The paper and its securitization proposal are focused precisely on this type of risk, and this will be the risk that will be securitized and then shared, through

derivatives that we will call *health-linked securities*, configurable in the context of Insurance Linked Securities (ILS). Among these forms of Insurance Linked Securities, we find the Cat (Catastrophe) bond, which derives from the securitization of catastrophic risks, among which pandemic risk can be included (see Section 3).

It is interesting to highlight how securitization in the insurance sector already has its own history, which, although quite recent and not without its critical issues, provides useful guidelines for similar products.

And not only that: previous experiences of securitization in insurance contexts, which have often been the result of ingenious and innovative schemes, show how certain specific risk sources can be managed by creating strategic advantage for several stakeholders.

We consider interesting to give a brief presentation of what we believe are “paradigm products”, so, in the following we provide a synthetic overview to describe the classic products already existing in securitization procedures of the insurance sector, retracing the presentation scheme shown in. For an in-depth examination full of details, it is useful to refer to Cairns et al. [15], Blake et al. [16] and D’Amato et al. [17].

In the last two decades, the expansion of the insurance sector in terms of innovative products (especially in the third pillar of the pension sector) has inevitably led to the assumption of new risks, as well as the amplification of the impact of traditional risk sources, especially the demographic risk sources. In particular, the criticality evidence of public pension systems has led to the need, which is strongly supported by the Regulatory Authorities in the field of pensions and welfare, to create new generation individual pension products (the so-called *personal pension products*, which in Europe are moving towards the design of highly standardized products, called *Pan European Personal Pension Products* (PEPPs)). Within this context, unexpected variations linked to the phenomenon of human survival constitute a risk source that could lead to inauspicious underestimations of future costs for the insurers; this is a risk source that can only be partially managed and mitigated by means of diversification techniques (pooling risk), but rather characterized by a dangerous systematic component deriving from the trend of mortality/longevity as a whole.

It is precisely the need to effectively manage demographic risks (with particular regard to the longevity risk, that falls like a cleaver on the balance sheets of annuity providers and pension funds) that has led to the birth of new derivatives. Thus, new markets for mortality/longevity derivatives have developed, albeit with differences in terms of evolution and volumes in the various geographical areas, whose main risk source consists precisely in the unpredictable variability of the human mortality/survival trend.

The debate on the contractual profiles of these derivatives, as well as the complex definition of their price, are still a burning issue for researchers and insurance operators. The best-known example is represented by mortality/longevity bonds aimed at transferring longevity risk to the capital market; basically, longevity derivatives are intended to cover operators exposed to longevity risk, who avoid more expensive forms of financing, such as reinsurance, and do not charge the contracts’ costs in a way which would not be acceptable for customers. The cash flows associated with longevity derivatives are substantiated in payments that vary as the number of survivors of a given population cohort increases, compared to the estimated number [18].

In addition to the best known “classical” mortality/survival derivatives (as *Longevity bonds*, *Survivor bonds*, *Mortality-linked securities*, *Survivor swaps*, *q-forward*, *S-forwards* and *K-forwards*, *Mortality options*), there exist other sophisticated and highly financially “engineered” products; they have been conceived and proposed to the market during the last decade and consist of call options on forward survival rates (the so-called *Longevity Experience Options*).

In summary, these derivatives have been conceived as tools for managing and controlling the impact of the demographic sources of a systematic nature. The risk-sharing dynamics allows the insurer to

finance itself and, on the other hand, investors, who purchase this type of securities, that are generally uncorrelated to the other assets in their portfolios.

Studying the evolution of the securitization markets in the insurance sector, as traditionally understood, is an effective exercise to look to the future, for a *sustainability and solidarity-based economy*. Focusing on the regulations of the European insurance, it emerges as supervisors and regulators are starting to incorporate sustainability into the way they oversee the sector [14]. Since 2013 the European Insurance and Occupational Pensions Authority (EIOPA) provided guidelines addressed to “*favorable but still prudent treatment of securitisations*” [19], so protecting policyholders and bringing stability to the financial sector as a whole. The Joint Committee of European Supervisory Authorities (ESA - European Banking Authority, European Insurance and Occupational Pensions Authority and European Securities and Markets Authority) in May 2021 published a detailed analysis on the implementation of the EU Securitization Regulation (SECR), also in view of the potential of securitization in the post-Covid 19 phase; however, we recall that the implementation of the SECR, launched in 2019, has led to an increase in the solidity and efficiency of the securitization market [20]. All regulatory efforts are therefore explicitly aimed at reducing securitization risks and ensuring transparency and effectiveness. All this for the *benefit of people, business and society* as stated in the EIOPA Report [19].

These efforts represent a significant step toward a new framework for reforming the entire global financial system, in an orchestrated manner, centered on sustainable approaches, models and instruments, involved in implementing the Principles for Responsible Banking (PRB), Principles for Responsible Investment (PRI), and Principles for Sustainable Insurance (PSI), [21–24]. As noted by Brogi et al [14], over the last few years, interest from the insurance sector in sustainable development, declined in different paradigms, though intensifying, thanks to the efforts of global nonprofit associations. More in detail, the UNEP FI-Principles for Sustainable Insurance (PSI) represents a global framework for the insurance industry to address ESG risks and opportunities. Launched at 2012 UN Conference on Sustainable Development, PSI initiative is the largest collaborative initiative between the UN and the insurance industry. The four Principles are based on the insurance industry’s core business to understand, manage and carry risk. The vision of the PSI Initiative is of a risk aware world, where the insurance industry is trusted and plays its full role in enabling a healthy, safe, resilient and sustainable society.

In this vein, sustainable insurance is defined as “a strategic approach where all activities in the insurance value chain, including interactions with stakeholders, are done in a responsible and forward-looking way by identifying, assessing, managing and monitoring risks and opportunities associated with environmental, social and governance issues. Sustainable insurance aims to reduce risk, develops innovative solutions, improves business performance, and contributes to environmental, social and economic sustainability” ([25], p.267).

More recently, the PSI ESG Guide for nonlife insurance [23,24] represents the first insurance guide on ESG issues aimed at raising awareness of the potential benefits of ESG integration in the insurance business model ([14], pp. 1357–1358).

The lessons learned from experience show the dark shadows of the securitization market and the need for in-depth reflections on linkages between securitization, ethics of risk management, and sustainability. Emerging issues in this field provide a perspective that stimulates and encourages the efforts for reforming and revitalizing the securitization market, according to the Shiller [4] approach, based on the concept that “finance should benefit society”. In particular, as stated by Buchanan [26], p. 674): “*there is a common understanding amongst European regulatory authorities that the criteria must be simple, transparent and standardized (or known by the acronym, STS). ‘Simple, transparent and standardized’ (STS) refers to the process by which the securitization is structured and not the underlying credit quality of the assets involved*”.

Our proposal deals with the UNEP-FI PSI [22–24] framework.

Narrowing the focus on SDGs of the Agenda 2030, furthermore, the securitized process here proposed could have a positive impact on SDG 3 (Good Health and Well-Being), SDG 8 (Decent Work and Economic Growth), SDG 11 (sustainable cities & communities), and SDG 12 (Responsible Consumption and Production).

3. Securitization and cat bonds to the challenges of the pandemic: exploring sustainable responses

The cat bonds are interesting and innovative financial instruments through which the Alternative Risk Transfer strategy is implemented, i. e., the transfer of exogenous risks by means of a strategy both of risk management tools and investment opportunities. The Cat Bonds are issued through the activity of an intermediary, the Special Purpose Vehicle (SPV), which places the securities on the market and physically collects the capital. The SPV receives a premium from the insurer through which it assumes the specific risks involved in the bond and generally in its traditional form, provides for the SPV to receive the price paid by investors. In this type of securitization, the task of the SPV is to issue the securities, place them with investors, and collect money, subsequently providing for the management of the flows originating from the derivative. The proceeds from the sale are usually deposited in a restricted fund, invested in sustainable activities. A typical cat bond has a cash flow structure not dissimilar to that of a normal security that pays coupons at regular intervals and returns the nominal value at the maturity of the security itself. This does not exclude, as will be done in this paper, that the security foresees a flow dependent on the performance of the underlying with respect to its expected values, which will be acknowledged to the subscribers from time to time.

Like all securities dependent on risk factors not strictly linked to those typical of the capital market, or at least not directly linked to the factors that are prevalent among them, they offer investors expected returns potentially very attractive and on average higher than the returns promised by corporate bonds with similar ratings. Furthermore, by investing in Cat bonds, as said above, investors manage to diversify their portfolios in an innovative way, with the well-known beneficial effects in the risk-return trade-off. On the other hand, again as said above, the insurer is able to cover potentially high and economically significant risks, also drawing not inconsiderable advantages in terms of reputation, a concept that is increasingly relevant and capable of orienting an audience of investors who are increasingly sensitive to social issues linked to collective well-being [18].

Implementing financial strategies aimed at health and economic needs, even in times of pandemic, requires capital availability and adequate financial infrastructure. The recent financial and insurance literature provides innovative ideas, proposing new contractual schemes, in which governments, firms, but also private and institutional investors, are protagonists [27–29]. Among the various proposals, some insurance solutions are increasingly stimulating, particularly suitable in pandemic phases, in which governments or other bodies in charge finance themselves through special “Insurance Linked Bonds” related to the pandemic in place ([27]; Erikson, 2019; [30]. Already some years ago, the economic and health emergencies related to flu pandemics and coronavirus, as well as to the Ebola disaster, led the World Bank to issue in 2017 two types of three-year pandemic bonds. There has been no shortage of critical reviews about these initiatives [26,31–33] especially since the pitfalls of securitization markets had already been revealed during the financial crisis that erupted in 2008, leading to mistrust and ethical-political questions about the opacity of the activities of many banks, especially the so-called shadow banks.

However, the systemic fragility exposed by the impact of the Covid-19 pandemic is a fact, even in economically advanced societies. Once again, and this time in a dramatic way, there is the need to resolve the atavistic contradictions that determined the gap between the objectives of the finance world and the social issues and needs, including the protection of public health and collective economic protection. And it is

precisely from the lessons of the recent past that guidance can be drawn to fully exploit the potential offered by securitization schemes that generate virtuous practices.

Financing the essential objectives of the United Nations Sustainable Development Agenda 2030 (SDGs) requires courageous and innovative actions. The amount of the investments is impressive – in the order of trillions of dollars – as communicated in the note by the Joint Ministerial Committee of the Board of Governors of the Bank and the Fund on the Transfer of Real Resources [34,35].

It is therefore necessary to involve a multiplicity of investors, able to inject liquidity into the market, acting on objectives that can be pursued in the long term; the strategies to be adopted are studied by the competent international authorities, which are responsible for settling regulatory issues and clear guidelines, while respecting capital and regulatory constraints.

The strategic lines under review inevitably include securitization [36,37] as a tool capable of moving significant liquidity, with particular reference to Sustainable Finance projects. This was recently dealt with by the High-Level Expert Group on Sustainable Finance, which presented its work in an interesting Report in 2018 [21], although studies on the subject were already underway for a few years.

In fact, already in 2015, the European Commission enacted measures to ensure liquidity in securitization markets [23,38], based on a list of criteria defining and identifying simple, transparent and standardized securitizations (STS). In addition, further changes were introduced by the European Commission in 2020 [39] to adapt the previous guidelines to the new financial environment determined by the pandemic.

In summary, securitization is a financial technique that makes some specific illiquid rights liquid through financial market-exchangeable instruments (Iglesias-Casal et al., 2020), then, how can we not use the peculiarities of such a technique to meet the needs posed at this critical time? It is not by chance that securitizations are included in the body of efficient and flexible investments, also in terms of de-risking strategies. This is increasingly significant in the perspective of the Sustainable Development Goals (SDGs).

We consider extremely interesting the possibility of seeing the issuer-insurer in the role of the entity which physically receives the amount paid by the investors for the purchase of the bond, configuring the operation in a financing for the insurer. We place our reasoning in the framework indicated by the European Commission's 2015 document ([40]; [41]), in which the strong motivation of the European Parliament and the Council of the European Union, to “re-launch quality securitization markets” is stated. There is reported that “the development of a simple, transparent and standardized securitization market is one of the founding elements of the Capital Markets Union and contributes to the achievement of the Commission's priority objective of supporting job creation and the return to sustainable growth.” The same document mentions, among the purposes inherent in securitization transactions, that of financing loans or exposures by transforming them into marketable securities. The idea of allowing investors to invest in credits and other exposures to which they would not normally have direct access is welcomed.

In the Italian legal system, all this is expressly provided for in a law issued in the so-called Milleproroghe Decree (Decreto Legge 162/2019), which introduces interesting innovations regarding securitization. In particular, we talk about securitization with financing. Basically, the scheme is as follows: the SPV provides an amount to the Originator by raising the necessary funds through the issue of the securities. In this way, the insurer acquires the funding with which it will be able to cover the costs of implementing a policy designed to reward good behavior by the community and the insured.

This will be the context in which our derivative will be framed. The proceeds obtained from the placement on the market of the securities issued by the Originator-insurer become the financing with which the insurer will carry out its activity to protect the wellbeing of the community.

4. An innovative securitization process of pandemic risk in insurance field: a proposal

What is set out in preceding sections leads us to imagine the securitization process as a circular system that feeds the implementation of projects with economic-social impact, which combine objectives declined according to principles of sustainability and inclusion. The strategic axis is collective wellbeing. Within this context, the insurance sector is called upon to play a proactive role, intrinsic to its peculiar activities, innovative and wide-ranging, which contemplates protection from extreme events (such as pandemics) with harmful consequences on inalienable priority rights, such as the right to health. Traditionally, in insurance business, securitization takes the form of risk sharing with the capital market.

Typically, in an actuarial framework risk sharing relates to risks arising from the contract (e.g., longevity risk in pension policy portfolios). Our idea, on the other hand, is based on sharing the goal of improving public health conditions, and thus sharing the risk not directly related to insurance coverage but to the spread of the pandemic. In short: if we all observe the rules to contain the spread of the pandemic, the investor will have won his “bet” and the insurer, thanks to the funding received, will activate policies aimed at “rewarding” its policyholders, also actors in good conduct. In the following the details.

4.1. The health bond and the financial cycle

The idea is to involve three economic actors in a virtuous cycle aimed at improving the well-being of the community.

Let's consider that a firm wants to cover its employees/workers from possible health damages due to some pandemic, as COVID-19 one. The insurer issues the policy for this coverage and adds an incentive consisting of a possible reduction in the premium in subsequent periods if the general trend of the pandemic shows an improving trend. Such premium reduction, that is a premium discounted of an appropriate percentage, thus becomes a decision and strategic variable in the hands of the insurance company, but it will also depend on the care that the

insured firm itself will put into implementing all the measures to contain contagion within the workplace. The insured company's attention to the protection of the health of workers/employees and to the workplace safety is thus stimulated by a reduction in the cost of next contract. It should be noted that visibility in terms of sustainability is extremely appreciated by insurers, increasing their reputational value.

The realization of this project is implemented through the issuance of bonds linked to the performance of the pandemic. These securitized bonds will be issued and managed by a Special Purpose Vehicle to which the insurer will pay an appropriate premium. The SPV will be responsible for pricing and marketing the derivatives and will pass on to the insurer the amount raised through the sale of the securities. At this point, after the insurer and the insured, the third actor enters the scene, the investor, who, by purchasing the derivative, will “bet” on the success of containing the pandemic and will not only participate in any profits linked to the security, but will also be an active part of a project whose aim is to raise the quality of public health.

The implementation of these dynamics is depicted in Fig. 1, in which the virtuous cycle of financial flows is shown.

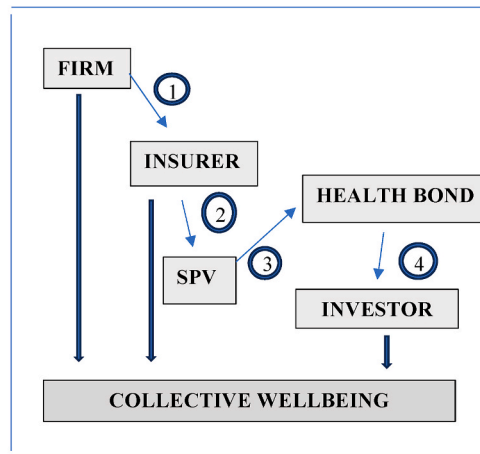
Those who purchase the bond will receive a stream of coupons, the value of which will depend on the trend of the underlying and, at maturity, the principal C. The underlying is the number of infected I_t as recorded at each maturity and its trend with respect to its expected value will affect the cash flow recognized from time to time to the insurer or investor, which are the two counterparts of the contract.

In schemes (1) and (2) below we describe the coupon cash flow that originates from the health bond introduced in the paper.

We will indicate by K the amount of the coupon cap, with I_t as already said, the number of infected at time t and with \bar{I}_t its expected value. The cash flow to the investor will result:

$$CFInv_t = \begin{cases} K & \bar{I}_t - I_t \geq K \\ 0 & \bar{I}_t - I_t < 0 \\ \bar{I}_t - I_t & 0 < \bar{I}_t - I_t \leq K \end{cases} \tag{1}$$

while for the insurer it will be:



- Legenda:
1. A firm buys an insurance policy to cover its employees from possible health damages due to some pandemic, paying a premium. The contract attributes a future premium reduction if few infections occur.
 2. The insurer buys a straight bond by means of a Special Purpose Vehicle (SPV).
 3. The insurer issues the health bond, linked to a pandemic diffusion indicator.
 4. The return from the investment of the bond price is used to pay the coupons to the investors and to insurer according with a plan of increasing coupons as the degree of infection decreases.
- All three players cooperate synergistically to the custody of health and wellbeing.

Fig. 1. The players in the health bond context and the financial flows.

$$CFIns_t = \begin{cases} 0 & \bar{I}_t - I_t \geq K \\ K & \bar{I}_t - I_t < 0 \\ K - (\bar{I}_t - I_t) & 0 < \bar{I}_t - I_t \leq K \end{cases} \quad (2)$$

This amount of the coupon depends on the insurer's strategic choice, following the classic structure of longevity-indexed derivatives, which are already widely established in the literature.

Fig. 1 shows in dark grey the key elements of an insurance structure based on two founding elements: the sharing of risk through securitization (Health Bonds) and the pursuit of the goal of improving the common good (Collective Well-Being). The three active protagonists of the operation are in light grey: the company, the insurer and the investor, all three cooperating in the pursuit of the common good. Behind the three actors, the network of financial flows (in the transparent boxes), activated thanks to the insertion of a third element, the Special Purpose Vehicle which enables the securitization itself. It can be seen, looking at the figure, that each protagonist (company, insurer and investor) is characterized by an incoming flow and an outgoing flow, an unavoidable circumstance which realizes an initial situation of financial equilibrium and therefore the feasibility of the operation itself. The company pays a premium to the insurer and receives, in addition to the coverage of the eventual damage, also a possible incentive that can be realized in the reduction of the premium for the subsequent period. The insurer, who undertakes, at the same time, to cover the damage and to recognize eventual premium reductions, receives the premium from the company and the eventual positive flow deriving from the securitized bond. It should be borne in mind that the insurer will also be required to pay the intermediation expenses to the SPV. Finally, the investor, meaning by this term the person who invests in the health security, pays the price of the bond to the insurer and will receive any positive flow deriving from the bond. All transactions are market "exchanges" and all transactions flow, in their ultimate purpose, to the common good. The "virtuous" company, through its contribution to good social behavior, will participate in improving the living conditions of the community, as will the investor, who will also be induced by his personal financial interests to behave in a manner that favors good behavior. The insurer becomes a crucial pawn for this mechanism to be activated.

4.2. A focus on the novelty of the proposed financial tool in the ESG framework

The proposed securitization process differs from the existing ones because its centrality lies with sustainability objectives, around which the entire investment structure is implemented. The analysis demonstrates how the securitization scheme generates and supports projects with economic-social impact, combining objectives declined according to principles of sustainability and inclusion. Indeed, the proposal focuses on health protection tools, by facing overall environmental, social and governance (ESG) facets of sustainability. Health protection – considered in public and private dimensions, as well as individual and collective dimensions - is a fundamental ESG aspect, that concerns the social topic (compliance with employment safety and health protection), the governance topic (employee rights guarantees), and the environmental topic (protection of healthy ecosystems).

Therefore, the product here proposed is in line with strategies for reaching SDGs goals and keeping a "just" transition process, that requires a radical transformation of the financial system, also in both its culture and incentives.

The product we propose can be considered within the wide perspective of the protection of society in general, which, in its broadest meaning, is realized in the management and control of risks related to environmental, social and governance aspects (ESG products). This is the proactive action that, oriented to develop social strategies of risk protection, gathers increasing interest in the perspective of sustainable development. Civil society appears ready for this new topic: investors are demanding such products, companies are increasingly offering them,

and regulations accompany and stimulate this trend, inspired by Principle Responsible Investment [42].

The investor can and is induced to make his/her choices within the framework of ESG criteria through different approaches, as indicated in Ref. [42], and those who turn to the insurance market operate in the same way, as widely explained in UN, 2020.

Among the 7 categories of Responsible Investment Strategies listed in Ref. [43], the health security in this paper in our opinion specifically hits two of them: Sustainability Themed, addressing in particular the issue of health (especially the health of workers), and the Impact Investing, which combines a socio-environmental impact with a financial result [44]. In particular, the latter is supported by actions planned and implemented in advance by the insurer, the impact of which can be measured by observing the effects on contagions.

Insurance business is thus also entering the world of impact finance, in a role that affirms and reinforces its traditional nature of hedging, protecting and controlling risks in the new light of sustainable finance.

Despite the Covid-19 pandemic has offered reasonable evidence of the validity and the potential effectiveness of similar financial instruments, our model unfolds potential social benefits in different context.

Concrete examples of the potential social benefits to point out consists in the pandemic risk securitization achieved in the aftermath of the global emergency of the Ebola outbreak declared over by the World Health Organization (WHO) spread to parts of Africa, Europe, and the United States, the largest impact being in Guinea, Sierra Leone and Liberia. Within the Pandemic Emergency Financing Facility (PEF), World Bank's IBRD issued \$320 million of pandemic bonds and \$105 million of pandemic risk linked swaps to provide capital markets backed reinsurance financing for the PEF [45]. According to the PEF [45], the pandemic bond consists in a "catastrophe bond issued by the Treasury Manager, under which agreed-upon payout(s) will be made available to the Treasury Manager through a reduction of principal amount of the bond due to the bondholders, upon meeting the Activation Criteria", that are the requirements to be satisfied "to activate a payout under a Pandemic Insurance or a reduction of principal under a Pandemic Bond". It is noteworthy that they are special bonds for investors being speculative, whilst for the World Bank they are an opportunity to collect funds to have a buffer to intervene in the event of health disasters. From the institution perspective, the bond placement relies on indisputable social value, "making available surge financing to key responders, including governments, multilateral agencies and civil society organizations, to respond to an outbreak with pandemic potential and to minimize its health and economic consequences and helping catalyze the creation of a global market for pandemic insurance instruments by drawing on resources from insurance, bonds and/or other private sector financial instruments" [45].

The bonds are intended to transfer pandemic risk away from developing countries and reimburse them while an outbreak is taking place.

Another emblematic example of innovative finance with significant spillovers in global health and development is represented by the vaccine bonds, issued by the International Finance Facility for Immunization (IFFIm), with immediate benefits to any children that Global alliance for vaccine immunization-Gavi would not otherwise have been able to vaccinate [46]. To complement the current system in terms of insurance coverage against the COVID-19 pandemic, coronabonds represent one of the most prominent alternatives in European response to the coronavirus crisis [47].

Interesting proposals for asset securitization financing for renewable energy enterprises in China allow to use the entrusted funds to purchase basis assets that generate stable cash flow and relies on the reinforcement of the social infrastructure, by integrating social and environmental objectives [48].

5. Achieving actuarial balance: a delicate task

5.1. Preliminary considerations

It is important to recall, with [15], that the procedure for pricing mortality risk, and even more so pandemic risk in which we are interested in this paper, cannot be done using a risk-neutral probability measure to achieve an arbitrage-free market, because of the incompleteness of that market. Alternatively, one can use a distortion operator by means of the Wang transform [49]) in order to construct risk-adjusted probabilities, to be used to price the security.

To approach this second way, it is essential to consider an ad hoc insurance contract that is priced and sold on the market: this means that the insured accepts the probability distribution inherent in the contract itself.

In Appendix (A.2), we will present the Wang transform for obtaining risk adjusted probabilities of pandemic spread.

5.2. The actuarial structure of the contract

In this section we will refer to a contractual scheme that provides for the payment of cash flows to the insured persons with sickness due to a pandemic. This scheme will constitute the “source” contract on which the securitization cycle described above will be based.

Actuarial research has always paid attention to insurance contracts aimed at covering for damage caused by epidemics, both in the case of individuals and in the case of firms.

In fact, the control and management of the health, economic and social consequences of pandemics are a problem that recurs dramatically over time. Looking back to the recent past, we need only to think, in the early years of 2000, of the SARS or avian influenza epidemic, until we reach the current period, gripped by the Covid-19 epidemic.

Actuarial research has significantly contributed over time both to the modeling of contagion processes ([50]; [51])), and to the definition of financial and insurance programs aimed at the protection of sensitive communities [29,52,53]. The proactive role of insurance companies is essential to manage the interaction between epidemiological and socio-economic risks, through financial cycles enshrined in appropriate insurance contracts. An overview of the initiatives taken by insurance companies, also in conjunction with national governments, was presented in a recent report by the Organization for Economic Cooperation and Development (OECD, 2020), with particular regard to supporting businesses suffering as a result of the pandemic.

Feng and Garrido [53] propose insurance schemes against the financial consequences due to pandemics, underlining the parallels with traditional cover in case of death or in case of damage to property. However, they also raise the question of the different variability in the number of policyholders paying premiums and those receiving compensation.

It should be remembered that even health insurance policies of another nature, such as those for long-term care (LTCI), are still recently introduced [54]. For this reason, the lack of appropriate biometric data for these policies also causes problems in pricing and evaluation, as well as in implementing capital requirements.

These problems are increasingly significant for “new generation” health insurance policies (as proposed in the bibliographical references just mentioned), which will over time play a key role in health care.

The urgency of the current situation linked to the pandemic is, in any case, causing a fervent activity of inclusion of covers linked to the spread of the contagion in pre-existing contracts or the development of new products linked to the trend of the same parameter.

Let's go now to the actuarial profile of the source contract, according to a financial equilibrium between premiums and benefits.

Consider an insurance scheme built on a closed community of policyholders, where the premiums $\{P_t\}_{t \geq 0}$ are paid in the form of annuities by susceptible but healthy persons, who will be granted insurance

coverage in the event of infection and death. This coverage is substantiated in the cash flows $\{B_t\}_{t \geq 0}$ paid until recovery or death.

The actuarial equivalence principle – well established in the actuarial literature [29,53,55–57]; - allows to calculate premiums on the basis of benefits, that are linked, in this contract, to the number of survivors at any time t (S_t) and the number of infectious persons (I_t). In Appendix (A.1) some technical details are described.

The aforementioned paper by Hainaut (2020) introduces the topic of describing the future evolution of the pandemic spread trend. The Author proposes, among others, a deterministic model calibrated on 4 parameters, describing the number of infected at a certain time t . The model explains the evolution of the so-called “first phase” of the spread of the virus, which has been shown to spread in various waves and in variable forms, also due to changes in the virus driving the infection itself. The availability of a greater quantity of data will lead to the formulation of models more adherent to the reality of the phenomenon, above all relatively to the trend in the medium term. The existence of various waves of contagion has made clear the circumstance that in the medium term, at least, it does not have a decreasing trend tending to zero (contrary to what is modeled by Hainaut, 2020, in which the first phase of the epidemic is specifically described).

We have described, and reported in Appendix (A.2), the application methodology to be followed in order to determine the “real world” probabilities, pandemic-risk-adjusted, to be used for pricing the derivative. We have chosen, for illustrative purposes, the Hainaut 2020 Covid-19 diffusion model.

6. Results

The innovative nature of the scheme we are proposing in this work is also linked to a very immature insurance market in the sector that will surely develop in the near future. This also implies an insurance market that, although already very sensitive to the pandemic problem, is just beginning to propose the first insurance coverage solutions. In Italy, only few companies are currently offering a contract linked in some way to the pandemic trend, precisely to the frequency of hospitalization.

To realize the virtuous cycle described in Fig. 1, the insurer has to issue the policies linked to the risk of incurring contagion and aimed at companies wishing to cover their workers/employees against this risk and to improve the workplace safety. Within the framework we have presented, companies will have to stimulate the insured company to maintain virtuous behavior by respecting the rules for the containment of the spread of the virus. This will happen by implementing a policy of discounts on contracts subsequent to the one in question, to be applied only if collective compliance with the rules has had positive results on the contagion. The percentage of discount to be applied becomes a decision-making variable for the insurer, which we will not go into here.

In what follows we will provide an evaluation of the health bond introduced in the paper, bearing in mind that at this early stage is not available a model to describe the performance of I_t nor even a source contract from which to derive the pandemic-risk-adjusted probabilities. Nevertheless, we will provide an experimental procedure from which to derive an evaluation of the investor's cash flow, as described in scheme (1).

The health security consists in the principal C , to be paid at the bond maturity, and in periodic coupons described in (1). For the purely descriptive purposes of this section, we will assume that we are referring to a single security and not the entire portfolio.

We consider a securitized pandemic bond with maturity 1-year, principal C due at the maturity and half-yearly coupons as in (1). It should be emphasized that in the face of the annual duration of the bond, the insurer does not necessarily have to issue pandemic policies with an annual duration, but also policies with an interim duration with the intention of renewing or issuing new ones during the year. The hedge is neither perfect nor symmetrical: within a year the insurer assumes a

pandemic risk by issuing one or more pandemic policies. The hedge is not necessarily symmetric in the sense that the pricing of the pandemic policies depends on the probability that the policyholder falls ill or be hospitalized [29] while the cash flows of the securitized bond depend on other indices related to the pandemic risk, such as in our case the number of infected in a given period I_t .

As shown in Eqs. (1) and (2), the cash flows of the insurer and investor are linked to the expected number of infected and the realized number in a given time interval. In this application we have considered the Italian data [58] and in particular the number of Covid-19 infected between 04/16/2020 and 04/16/2021. We suppose that the securitized bond is issued on 04/16/2021.

We want to underline that these work hypotheses have been conjectured to the exemplificative scope only, because of the initial objective impossibility to implement the model presented in appendix A.2.

In this example we consider an annual bond with first and second half-yearly flows and nominal value $C = 1000€$. In the following calculations, the expected number of infected people recorded in the annual bond duration is considered the same as that one recorded in the preceding period, starting from 04/16/2020. In particular, the first and second half-yearly flows are calculated considering the average value of infected people recorded respectively in the first and second half of the considered year.

Table 1 reports the results of the sensitivity analysis of the securitized bond to changes in the coupon cap (see formula (3) in A.1). In the construction of the bond, the key strategic variable at the decision-making level is the cap that the insurer sets and diffuses to potential investors.

The value K represents the coupon cap, i.e., the maximum value to be paid at the end of the period to the investor if the parameters related to the pandemic prove favorable and thus bring an economic advantage to the investor. To this end we have analyzed the sensitivity that the expected value of the flows, calculated at the bond issue time, shows when K varies. In the columns of Table 1 we have assigned increasing values to K , starting from 50 with increments of 25, up to a maximum of 150. We will not discuss here the time and costs of securitization, legal fees, any fees to rating agencies and banks, actuarial and modeling costs, and any costs related to regulatory issues, considering that these expenses, not depending directly on K , do not affect the present value of the flows. The values shown in Table 1 are consequently calculated net of these costs. The results reported in the table highlight the increase in the expected value of the flow as the cap increases. This trend, which is certainly predictable, shows in particular a greater sensitivity of the expected cash flow to low cap values.

7. The actors' and stakeholders' point of view: factors of success, challenges, and opportunities

According to Porter and Kramer [59], corporate shared value is represented by a set of policies and operating practices by which companies create economic value through societal benefits. In particular, firms, insurance companies and institutions integrating the social dimension in the investments play a crucial role in both economic development as well as having a role in supporting wider societal ends. Broadly speaking, they are required to meet the increasing expectations from stakeholders especially by making strategic decisions which take into account the core social utility in the long run of their activities.

The product we propose integrates the dimension of social sustainability, as the original definition of UN Global Compact, determining “the identification and management of business impacts, both positive

and negative, on people”. The policy efficiently protects the employees through innovative risk mechanisms accomplishing a sort of sharing scheme, by transforming fundamentally the atmosphere of the workplace by eliminating the traditional conflict between workers and the firm. Indeed, according to Cable and Fitzroy [60] and Blinder [61] and the cooperation raises the workers' effort due to maximization of joint wealth.

Generally, an improvement in the relationship between the employer and workers is achieved whenever the workers are treated fairly, also obtaining fair compensation [62]. Nevertheless, the social-oriented policy we set up is based on social stakeholder expectations relating to the healthcare, with the aim of building healthier, safer, more resilient and more economically productive companies. In particular, the policy Provider assumes an innovative strategic role addressed to social sustainability issues, in the healthcare of employees perspective. The Employer and the employees agree that they mutually desire to maintain standards of safety and health in the firm activities, in order to prevent injury and illness. In general, the economic costs of the occupational hazards and involved injuries and deaths are huge, at the enterprise, national and global levels. “Taking into account compensation, lost working time, interruption of production, training and retraining, medical expenses, and so on, estimates of these losses are routinely put at roughly 4 per cent of global GNP every year, and possibly much more” [63].

From the firm point of view, our product, which is in line with the SDGs, is consistent with the corporate welfare according to the business objectives such as protection and safe in the marketplace.

From the insurer point of view, the contract we design allows to achieve the benefits of securitization such as creation of liquidity, risk reduction and transfer, regulatory capital relief and so on. Furthermore, discount policy is based on principles which appear to be more straightforward.

The design of sustainable products, such as this policy that permits businesses to care for the health and safety of their employees, aims at twofold significant objectives: increasing long-term profitable growth by integrating social commitments in the different lines of business, consistent with SDGs to contribute to global development. The social values embedded in the policy strengthen an industry which is viewed as inherently socially beneficial, which is based on concept of solidarity achieving a mechanism of risk sharing that properly represents the core business of the insurance.

Furthermore, the contract could address the protection gap in healthcare system by reducing the asymmetries among different regions, producing externalities in the health services.

As in its most basic form, securitization represents a sort of risk sharing strategy among the investors and other parties involved in the transaction. The inflows arising from this mechanism are invested to provide reward programs for virtuous firms by means of discounts and offers on the health policies. Actually, the insurance market typically provides discounts including no-claim bonus, cumulative discounts on premiums, reward points to those who have a good lifestyle, exclusive discounts for women, vouchers, etc. Nevertheless, according to our proposal the significant discount can be offered to the firms with a low number of the infections in a temporal reference interval before of the premium payment. In other terms, the innovation of the sustainable product we propose relies on a pushed relationship between low risk and high rewards that encourages prevention behaviors involving actions directly on the risk before the event, by altering either the probability of the event's occurrence or its consequences. Another compelling reason for promoting this kind of product consists in its capacity to enforce also precaution that is another form of risk protection, as stressed by Paula Trienens Institute for Sustainability and Energy (Risk and Reward | Institute for Sustainability and Energy at Northwestern (ISEN)) “whereas prevention relates to the idea of acting on the ‘known risk’ before the event, precaution involves the dynamic posture of being vigilant and watching out for more evidence on a potential risk, and then

Table 1
 P_{inv} value as the coupon cap increases.

K	50	75	100	125	150
P_{inv}	1018.725	1029.808	1040.365	1050.394	1059.935

making adjustments as more information is gathered”.

The aspects of preventions and precaution strictly related to the reward incentives avoid biases in the individual behaviors such as charity hazard. It determines the individuals' tendency not to insure or take any other mitigation measures “as a result of the reliance on expected financial assistance from federal relief programs or donations by other individuals” (Raschky et al., 2007). Another interesting advantage related to the sustainable product under consideration depends on the good reputation due to the social impact of the policy. According to the paradigms of the Behavioural Finance, it can create an economic value addition in the insurance value chain (Heidinger et al., 2017).

From the investor point of view, a positive mixing between risk-return trade off and social outcomes can be achieved. The investors take advantage from the uncorrelation in respect with other classes of assets, investing in good reputation assets involved in strategic topics such as the public health. Broadly speaking, we design a sustainable product in line with the principle of double materiality (outside in, i.e. social development impacts on the insurance activities, inside-out, i.e., company impacts on social system and public wellbeing) as codified for the Environmental dimension of the ESG in Ref. [64]. Under EU's Sustainable Finance Disclosure Regulation, according to the Article 9, we try to offer a sustainable product, so-called dark green, that is ‘a financial product that has sustainable investment as its objective and an index has been designed as a reference benchmark’ whereas the light green only has ‘environmental or social characteristics, or a combination of those characteristics, provided that the companies in which the investments are made follow good governance practices.’ The contractual scheme we provide fits under Article 9, since it meets its requirements, specifically having a positive impact on the society.

7.1. Some macroeconomic considerations

The discussion addresses some of the potential macroeconomic implications of the methodology used in our proposal by focusing on its innovative contributions, in terms of its positive impact on human welfare, in light of the renewed perspective of academic finance [65]. In this regard, the macroeconomic impact of financialization was analyzed in the work by Gimet et al. [66], who have contributed to anchoring the investigation of policy responses. However, from a macroeconomic perspective, both impacts of privatisation measures and financialization are highly debated [67]. In recent years, economic-policy debate, in fact, warns against the risks of financialization, and in particular the financialization of healthcare. Financialization – of which securitization is one of the various aspects - was generally seen as a solution for governments struggling with austerity and trying to provide public services simultaneously. The opportunities and risks of transforming healthcare into marketable and traded assets for global investors have been analyzed by several studies [68,69], discussing the extent to which financialization entails a decline in the state's role. Cordilha [70] discussed the impact of the increasing financialization on public sector behavior and the effects for solidarity, stability, and democratic participation.

In this vein, Hunter and Murray [68], p. 1266) underlined that some studies on the financialization practices of health care have highlighted inequalities, rising costs, and market concentrations, pointing out that the expansion of private finance for public projects and common goods raises important questions about the decline of the health care system as a social institution and its implications for equity (p. 1277).

Their argument does not focus on technical considerations regarding the characteristics of specific financial instruments, while discuss the extent to which financialization implies a deterioration of the social contract.

Buchanan [26] highlighted the problems associated with risk management and ethics in the securitization process.

Our proposal meets the criteria for creating a sustainable market for high quality securitization: the asset appears to be a suitable candidate

for securitization, the risk is transferred to appropriate intermediaries/entities, and the process is in line with the “STS (*simple, transparent and standardized*) criteria”.

Our model could represent a tool for policy change in an innovative frame of sustainability and sustainable finance. More in detail, according to the innovative approach that rebuilds finance on an “ecological basis” [71,72] - our proposal takes into account socioeconomic spheres, while sustainability is a prerequisite to our investigation and finance is embedded within economic, environmental and social concerns.

Our model responds to the need to implement in the real world and future business scenarios an innovative vision of finance. It can be said that we are currently facing a migration of classical instruments into new axiomatic and modeling structures.

The choice of quantitative modeling that is suitable for economic scenarios formalized on axiomatic bases and mind-set different from the classical ones in finance, is food for thought that offers the starting point for further future research. This, for example, is particularly important in relation to pricing. This topic, widely covered by Walter [73], is a complex epistemic theme that pertains to the formal and substantive modeling structure in Sustainable Finance. To avoid areas of opacity, or “faulty risk culture” due to the implementation of neoclassical financial modeling in scenarios relevant to sustainable finance, Walter confirms the need for a change of paradigm. The latter involves, among others, the consideration of fractality in financial risk modeling, mainly in Ecological Finance Theory.

In our paper, the “morphology of randomness” (cf. Walter [73]) essentially involves morbidity trends, while the financial component is based on a risk-free rate, for sake of simplicity.

The concept of circular sharing of financial commitment to health protection is the driving force behind the securitization mechanism; the involvement of a multiplicity of actors, disparate in roles and competences, but united by a long-term vision about sustainability principles as well as the community's protection, originates a model far from the scenarios that could lead to the financialization of the economy or, even worse, of the social policies. Indeed, clear indications of policies related to sustainability objectives, are the heart of the entire securitization scheme.

The proposed mechanism has as its ultimate goal the virtuous behavior of all actors, which, through the involvement of private resources, contributes to the achievement of social objectives, also in harmony with actions implemented with public resources.

8. Conclusions and implications

On the one hand, the insurer who issues a pandemic policy grasps a new business opportunity offered by the particular situation we are experiencing, triggering a virtuous process that generates sustainability and well-being for the society; on the other, however, it assumes an important risk, the dimension of which has been violently manifested in the last year. In light of what has happened, the pricing of pandemic policies would assume excessive and sometimes unsustainable values by companies that want to cover their workers from this risk. To make the price of these policies attractive, an instrument that the insurer can use is the securitization of the pandemic risk. The paper has tackled this problem for the first time, presenting the securitization of the pandemic risk as a useful means to realize the virtuous cycle we have described. Part of the risk can be outsourced and transferred to the SPV which in turn transfers it to financial investors with appropriate financial pricing. Investors' interest in purchasing these securities derives not only from portfolio diversification needs, but above all from reputational reasons. It is now well established that many institutional investors such as investment funds are looking for sustainable investments to improve their image on the one hand and to exploit the accounting advantages towards which the regulations of various countries are moving.

Therefore, the securitization of pandemic risk promises to be an effective tool for managing pandemic risk. Although it is hoped that the

introduction of vaccines will have a total effectiveness to eliminate the number of positives, it is estimated that this will take place within another year. But experts believe that even as we emerge from the current pandemic, we will face cyclical pandemics in the future. It therefore appears a challenge in the coming years to design financial and insurance instruments to invest in sustainability and support the well-being in the broad sense of society and the economy. Future research could empirically investigate whether and how this model will be adopted by the financial market, using questionnaire research and individual interview.

This work has both practical and social implications. Alternative and sustainable instruments allow firms, insurance companies and investors to play a proactive and positive role, which is substantiated in the dissemination of processes and services to ensure the collective well-being, with health as the primary objective. For their part, virtuous companies, attentive to health protection of their employees, could benefit from premium discounts on the costs of insurance coverage for business risks. The social repercussions of the securitization cycle are primarily reflected in the correct fulfilment and, indeed, in the improvement of company practices to protect workers' health, and, consequently, in an overall benefit for collective health. The social impact of the securitization cycle in the paper is confirmed by the promotion of good practices related to health standards at work and, therefore, in the improvement of health related to the workplace; the repeated implementation of the cycle generates improvement of collective health. Virtuous companies, because of the reward mechanism provided in the proposed scheme, will increasingly motivate the

development of actions that generate a positive impact. Insurance companies, for their part, will be the engine of the benefits that impact collective health. Finally, the paper provides evidence on how the insurance industry could collectively improve ESG product offering. The proposed product enlarges the range of the ESG (socially responsible) investment opportunities for sustainable investors.

CRediT authorship contribution statement

Valeria D'Amato: Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Emilia Di Lorenzo:** Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Gabriella Piscopo:** Writing – review & editing, Conceptualization, Formal analysis, Methodology, Writing – original draft. **Marilena Sibillo:** Conceptualization, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. **Annarita Trotta:** Formal analysis, Methodology, Writing – original draft, Writing – review & editing, Conceptualization.

Declaration of competing interest

None.

Data availability

No data was used for the research described in the article.

Appendix

The aim of this appendix is to propose a model that can be applied for realizing the pricing of the bond proposed in the paper. The basic observation from which to start is that the market to which we refer is incomplete, so the risk-adjusted probabilities cannot be estimated directly from the market. Therefore, it is appropriate to illustrate the pricing methodology offered by the Wang transform, which allows deterministic probabilities to be transformed into probabilities that can be interpreted as “risk adjusted.” In order to implement Wang's procedure, it is necessary to be able to assume that there is a market in which the uncertainty associated with the phenomenon being controlled is considered and that, as a result, investors refer to these same probabilities. While this procedure is accepted in the literature for established markets such as retirement annuities, it is still not applicable in markets in their embryonic state, where there is no established reality of contracts referring to the same phenomenon. For example, (see Ref. [74]), an appropriate proxy for the market price of a life annuity issued on a male aged 65 can be calculated using appropriate rules of the specific country applied to determine the survival probabilities, linked to the population characteristics. By means of these probabilities it is simple to calculate the market price of the annuity and to compare it with its corresponding value based on a Lee Carter model probability. The difference between these two values can be interpreted as the risk premium. We need this proxy to apply the Wang transform for getting the distortion coefficient and it is not at the moment available in the newborn market.

A.1 Premiums and Benefits

The actuarial equivalence principle [29,53,55–57]; allows to write the following formula involving premiums and benefits:

$$\sum_{t \geq 0} P_t v(0, t) \mathbb{E}[S_t | \mathcal{F}_0] = \sum_{t \geq 0} B_t v(0, t) \mathbb{E}[I_t | \mathcal{F}_0] \quad (3)$$

where $v(0, t)$ is the discounting factor based on the risk-free rate $i(0, t)$ of the contract, $\mathbb{E}[\bullet | \mathcal{F}_0]$ is the expectation of the survivors S_t (the infectious persons I_t , according to the case), under a probability measure \mathbb{P} within a complete probability space $\{\Omega, \mathcal{F}, (\mathcal{F}_t)_{t \geq 0}, \mathbb{P}\}$ endowed with a filtration $(\mathcal{F}_t)_{t \geq 0}$, that is a family of sub- σ -algebras of \mathcal{F} , with $\mathcal{F}_s \subseteq \mathcal{F}_t$ if $s \leq t$.

A.2 The SIR Type Models and the Insurance Plans: recalls from literature and the Risk Adjusted Probabilities

Following [15], unlike financial contracts, where risk can be priced through a risk-neutral probability measure different from the real-world probability measure, in cases like the one of our interest a risk-neutral probability measure may not be uniquely determined, due to the incompleteness of the market for these instruments, and again [15] note that the choice of probability measure becomes part of the modeling process. The underlying in question ties these contracts to the non-life insurance market, with which they share key characteristics.

The problem of pricing bonds linked to trends in phenomena such as human survival or, as in this case, trends in the spread of pandemic infection among the population, rests on the question of the incompleteness of the markets for these financial instruments. It follows that the estimation of risk-adjusted probabilities cannot come, so to speak, directly from the market. In markets characterized by a lack of liquidity, it makes sense to use the Wang transformation [49], through which projected probabilities of a deterministic type can be transformed into probabilities that can be interpreted as risk-adjusted ones.

In order to develop the pricing model of our health securities, we can use models through which we describe the trend of the contagion phenomenon and then apply the Wang transform to determine the distorted probabilities. In what follows we will give some brief hints to such methodology.

The guidelines of [29,53] indicate a community of S_0 individuals in a pandemic environment of the SIR (Susceptible-Infected-Recovered) type [75]:

$$S_0 = S_t + I_t + D_t, \forall t \tag{4}$$

where S_t is the number of individuals exposed (*susceptible*) to infection at time t , I_t is the number of *infected* individuals at time t and D_t is the number of *deceased* individuals up to time t . Since the cohort is closed, the number of susceptible individuals increases as the number of infected individuals who recover from the disease increases but decreases as the number of newly contaminated ones increases.

The stochastic trend over time of the three processes will be described in the following, in order to maintain the greatest possible generality in the phase of definition of contractual profiles.

In order to characterize the insurance product, we will refer to the very recent proposal of [29]. This choice is not decisive in the context of the proposed securitization model in the present paper, as the choice of contract is not binding for the dynamics that our model determines. As a matter of fact, the contract, which we will call the “*source contract*”, concluded between the company and the insurer, could also be structured in different forms, provided that it takes into account the events related to the contagion, as described above. The idea of [29,53] will allow us to work on a streamlined and simple contractual structure; the current price of the insurance contract will then make it possible to price the product generated by the securitization.

In the following, therefore, we recall the essential elements of the papers mentioned. Since the epidemiological evidence shows that “*the rate of increase in the number of the infected is proportional to the number of susceptible individuals and the number of individuals previously infected*” [53], the SIR model, in deterministic context, can be structured by the following system of differential equations, according to the definition of [29]:

$$\begin{aligned} dI_t &= -(\alpha + \mu)I_t dt + I_t \frac{\gamma}{t} dt, t \geq 0 \\ dS_t &= \alpha I_t dt - I_t \frac{\gamma}{t} dt, t > t_0 \\ dD_t &= \mu I_t dt \end{aligned} \tag{5}$$

where α is the recovery rate from the disease, μ the death rate of infected individuals, $\frac{\gamma}{t}$ represents the initial contagion rate per capita. For further information on the model, refer to the paper by Ref. [29].

Based on the above, we will be able to provide numerical examples of the *core model* (the securitization scheme) that we are presenting.

Starting from formula (1) and considering that the payments take place if the insured is infected at that moment, indicating with T the instant of occurrence of the contagion, the benefits in t_k will be paid if T is less than the instant in which it occurs, that is with the following probability:

$$F[t_k] = P\{T \leq t_k\}$$

in which:

$$F[t_k] = \frac{\sum_{j=0}^{t_k} I_j}{S_0} \tag{6}$$

As in Ref. [16], we will adjust for risk the probabilities in (6) to be used to calculate the expected values in (3) by means of Wang’s distortion operator. Denoting by $\Phi(u)$ the standard normal cumulative distribution function, we can write:

$$g_\lambda(u) = \Phi[\Phi^{-1}(u) - \lambda] \tag{7}$$

where $0 < u < 1$ and the parameter λ is the market price of risk that captures systematic risk. Applying the Wang transform to our case, considering a distribution with a cumulative density function $F(u)$, we will obtain the distorted distribution $\tilde{F}(u)$ as in the following formula is shown:

$$\tilde{F}(u) = g_\lambda(F(u)) = \Phi[\Phi^{-1}(F(u)) - \lambda] \tag{8}$$

The possibility of using the distorted cumulative distribution $\tilde{F}(u)$ comes from the determination of the parameter λ contained in (8). Specifically, the fair price of the liabilities will be the expected value obtained under the distribution obtained from the distorted measure in (6). As noted in Ref. [76,77] we may use the market prices of the source contract suitable for the case considered (see formula (3)), to solve the following equation in the one unknown λ :

$$\sum_{j \geq 0} F[t_k] B_j = \sum_{j \geq 0} \Phi[\Phi^{-1}(F(t_k)) - \lambda]$$

Once determined the distortion parameter λ , it will be possible to identify the distribution of the risk-adjusted probabilities.

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