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Circular Bioeconomy and the Forest-Wood Sector: Bridging the Gap between Policies and Disadvantaged Forest Areas

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Abstract: The adoption of circular bioeconomy (CBE) strategies in forest-wood supply chains is a possible avenue for the future of this sector. However, the uptake of CBE models may face several barriers in the coming years, particularly in disadvantaged forest areas lacking appropriate resources and a suitable business environment to start radical innovation pathways. Based on interviews with 29 representatives (business actors and other key informants) of the forest-food sector of the Salerno province (Italy), the current study investigated the main strengths, weaknesses, opportunities, and threats (SWOT) involved in the transition of disadvantaged forest areas into a circular bioeconomy. Respondents also contributed to identifying the most suitable strategies in order to foster the CBE transition in the territory at hand. The paper offers an outlook for the potentialities of CBE in disadvantaged forest areas for policy actors, willing to bridge the gap between CBE agendas and territorial development challenges. The role of policy actors is particularly crucial, in order to patronize investments, stimulate improved know-how and cooperation, and fix policy inconsistencies related to biomass valorization.

Keywords: bioeconomy; circular economy; forest sustainability; wood waste; wood by-products; wood recycling; upcycling

Citation: Borrello, M.; Altomonte, E.; Cembalo, L.; D'Amico, V.; Lombardi, A. Circular Bioeconomy and the Forest-Wood Sector: Bridging the Gap between Policies and Disadvantaged Forest Areas. *Appl. Sci.* **2023**, *13*, 1349. https://doi.org/10.3390/app13031349

Academic Editor: Apostolos Giannis

Received: 30 November 2022
Revised: 14 January 2023
Accepted: 16 January 2023
Published: 19 January 2023

1. Introduction

In recent years, circular bioeconomy (CBE) has become an emerging concept in academic debate and business circles, as well as at the center of national and international policy agendas. A CBE approach aims to re-design linear bio-based production systems (e.g., agriculture, fisheries, forestry, food processing, etc.) based on a set of key tenets; these include the following: closing loops of key nutrients to restore the natural capital; upcycling biological waste and by-products based on the eco-effectiveness principle; and implementing cascading processes to maximize the economic value generated by the recovery of bio-based materials [1–4]. According to the definition provided by Stegmann and colleagues ([5], p. 5), "*The circular bioeconomy focuses on the sustainable, resource-efficient valorization of biomass in integrated, multi-output production chains (e.g., biorefineries) while also making use of residues and wastes and optimizing the value of biomass over time via cascading. [. . .] The cascading steps aim at retaining the resource quality by adhering to the bio-based value pyramid and the waste hierarchy where possible and adequate*". Therefore, the CBE also entails the establishment of intersectoral collaborations, through which the embedded economic value of organic materials is fully exploited by means of various technological processes [6,7].

Due to its contribution to a more sustainable use of natural resources, while simultaneously generating economic value, the adoption of CBE strategies in forest-wood supply chains is a potential opportunity for the future of this sector [8–12]. In Europe, from the 160 million tons of wood processed annually, only 20 million tons is preserved in material products for a period of long usage [13]. In particular, along forest-wood supply chains,

different sources generate various kind of wood waste, such as wood packaging, discarded products from demolition and construction, residues from the wood processing industry, and others such as private households and railway construction wastes [14,15]. Starting from this waste, the forest-wood sector is prone to activating cascading processes, for example, by using wood waste in paper production, whose fibers and organic sludge can then become feedstock for the chemical industry [16]. Wood biomass can be also upcycled to develop new products, such as bioenergy, raw material for textile industries, nanofibers, bio-composites, biodegradable plastics, polymers, food additives, and pharmaceutical products [11,17,18].

Notwithstanding the opportunities that wood waste reutilization offers to the forest-wood sector, the transition to a circular bioeconomy model that fully exploits its potential is not straightforward [7,19,20]. The forest-wood sector is a "mature industry", hard to change and innovate, as it is strongly anchored to the traditional business culture and focalized in high-volume production [21]. On the contrary, the CBE transition asks forest-based sector firms to change their business models and to develop new products and services [22,23]. Cross-sectorial collaborations, innovative consortia, multidisciplinary expertise, dynamic organizational structures, and managerial commitment are also crucial to nurturing the emergence of CBE models [5,21,24,25]. In North European countries (e.g., Finland, Sweden, Norway), where the innovative forest bioeconomy and the related businesses are pillars of economic growth, the forest-wood sector has seen the opportunity to mature and diversify in line with these requirements; this contributes to giving birth to new circular products and businesses models [26,27]. However, in geographical areas where the forest-wood sector has traditionally had a lower economic relevance, undertaking these transformations is far more challenging [28–30]. This is, for example, the case of Italy, where, despite the existence of strong regional differences and excellence hotspots [31], the forest-wood sector has always struggled to express its full economic potential, and the management of forest areas is currently experiencing a state of abandonment [30,32]. One can consider several elements to illustrate the state of the Italian forest-wood supply chain: despite the fact that more than one third of the Italian territory is covered by forest, more than two thirds of the national supply chain depends on the import of raw materials; forest harvesting infrastructures and sawmills are disappearing; only 18% of the forest surface is managed according to a forest management plan; 72% of the firms are one man businesses and only 7% are share capital enterprises; and, over the years, the number of companies and workers in the wood cutting businesses for construction and furniture have dramatically fallen (by 27.8% and 34.4% in the period 2008–2017, respectively). When it comes to the state of the circular bioeconomy, data shows a low level of innovativeness and product differentiation, with approximately 95% of the recycled material used to produce particleboard or fiberboard for the furniture sector [32].

Against this backdrop, the current paper posits that the expectations for the uptake of CBE strategies in the forest-wood sector in the next years may face several barriers. In particular, the incumbents of disadvantaged Italian forest areas might not own the resources and the business environment required by a CBE transition. As recent CBE policies have suggested the application of advanced technological processes to upcycle biobased materials (e.g., the New EU Forest Strategy for 2030 [33]), this paper addresses the limits of this guidance for disadvantaged forest areas. Without contextual insights on drivers, barriers, and potential strategies for circular bioeconomy transition in the forest-wood sector, CBE policies may fail. Therefore, the main objective of this study is to contribute to generating geographically situated knowledge on these topics. This objective is consistent with previous studies seeking strategies to develop forest circular bioeconomy supply chains that are tailored to geographical contexts (e.g., [34–37]). In Italy, where the current study was performed, previous studies on forest circular bioeconomy have been focused mainly on technological issues (e.g., [38–40]), on the market aspects and financial performances of sustainable forest management (e.g., [41–44]), and on specific tree species (e.g., [29]). To the best of our knowledge, this study is the first to provide a comprehensive

socio-economic understanding of how to approach a circular bioeconomy transition in the forest-wood sector of Southern Italy.

More specifically, the current research raises the two following research questions:

(1) What are the strengths, weaknesses, opportunities, and threats to the transition of disadvantaged forest areas into a circular bioeconomy?
(2) Which strategies can be adopted to foster the transition?

To answer the two questions, information gathered by interviewing a set of forest entrepreneurs and other key informants was used. More specifically, the paper presents the outcomes of a qualitative analysis of the interaction with experts, business actors and other representatives of the forest-wood sector of the Salerno province (Southern Italy). An inductive process was used to generate a SWOT analysis of the interviews and to derive the appropriate strategies for the transition in the context at hand. The paper offers an outlook of the potentialities of CBE in disadvantaged forest areas to policy actors willing to bridge the gap between CBE agendas and territorial development challenges.

2. Material and Methods

2.1. Study Area

Wooded areas cover 36.7% of the Italian territory, with approximately 11 million hectares (ha) classified as *Forests* and approximately 2 million ha classified as *Other wooded lands* (shrublands, new woodlands and Mediterranean scrub). The Campania region (Southern Italy) extends over an area of 1,359,025 ha, of which 491,259 ha (36.1%) consists of wooded areas (403,927 ha classified as Forests and 87,332 as Other wooded lands) [45]. The current study was performed in the territory of Salerno, the most extended province of Campania, where woodlands cover a substantial portion of the territory. The Salerno province is the widest wooded area in the region, possessing a wooded surface of 230,416 ha (46.5% of its area) [46], a greater diversification of forest typology (Figure 1) and several protected areas. Particularly, the Cilento, Vallo di Diano and Alburni National Park, one of the most important bio-geographical sites of Southern Italy, includes 80 municipalities and covers an area of more than 180,000 ha; it is thus ranked second, by extension, among all Italian national parks. However, more than half of the municipalities of the Salerno province are classified as "*Rural areas with general development problems*" by the regional Rural Development Programme (RDP) (Figure 2), including mainly hillside and mountain municipalities with a low population density. Thus, this territory gives a flawless picture of the Italian forest-wood sector: geographically prosperous in terms of resource amount and diversity, but unable to fully develop its economic potential.

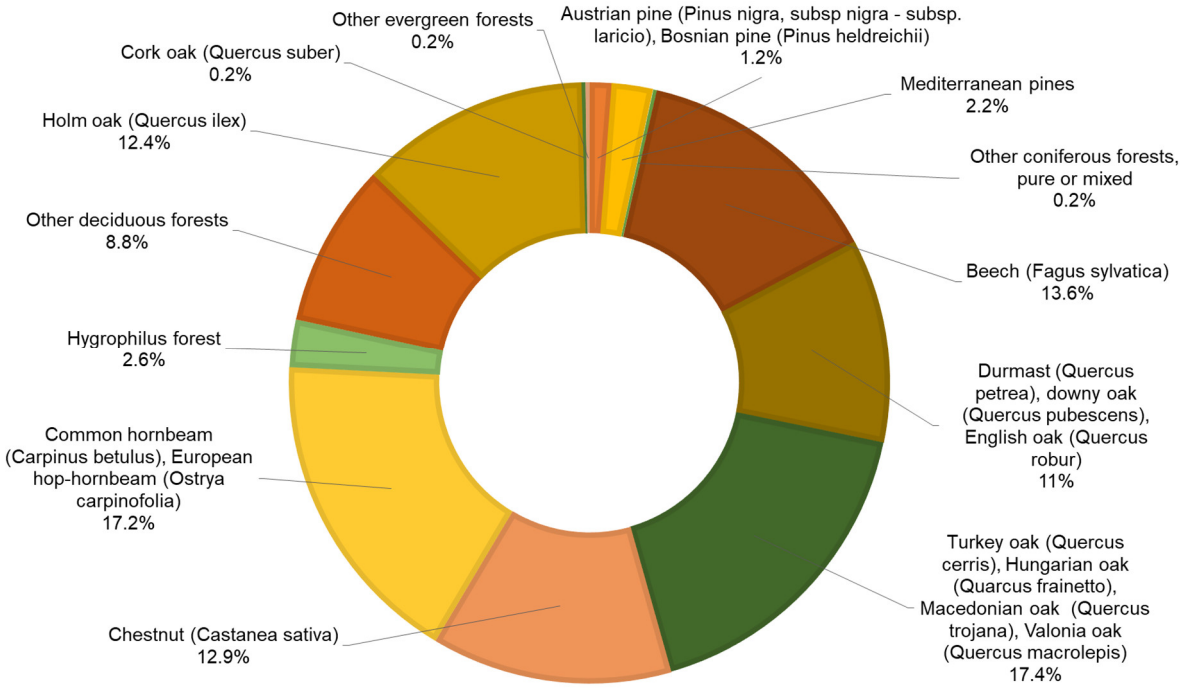

Figure 1. Forest typologies in the Salerno province by surface (percentages of the total forest area).

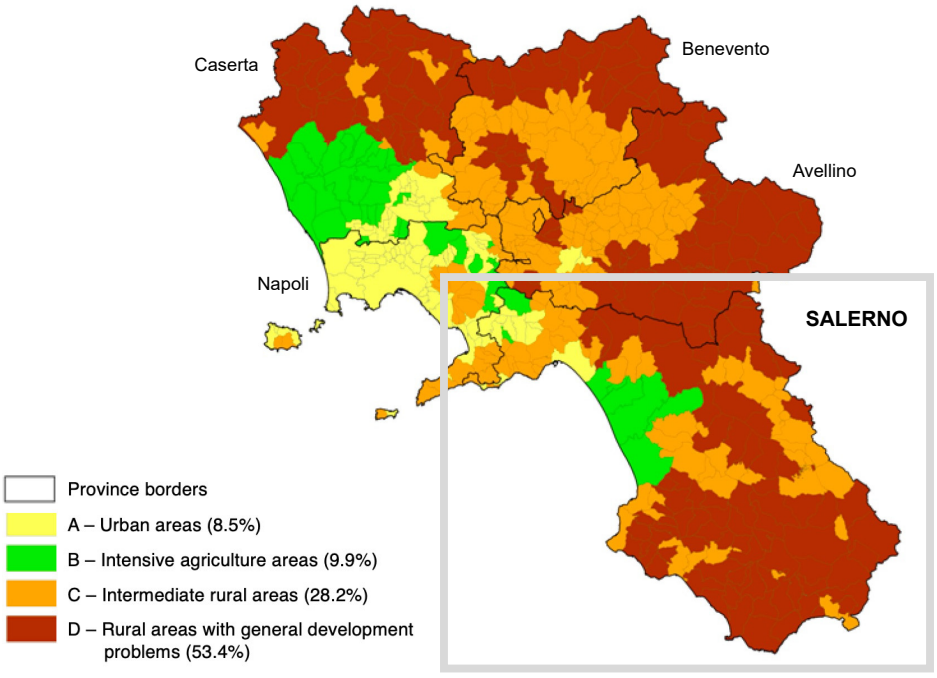

Figure 2. Regional classification of macro-areas adopted in the Italian Rural Development Programme 2014–2020 (figure adapted from the RDP of the Campania region).

2.2. Characteristics of Interviews Participants

In total, 29 individuals were involved in the study, distributed homogeneously in the entire territory of the Salerno province (Figure 3). Respondents were distributed as follows: 17 were firm representatives (hereafter *entrepreneurs*) and 12 were knowledgeable professionals of the forest-wood sector of the Salerno province (hereafter *key informants*).

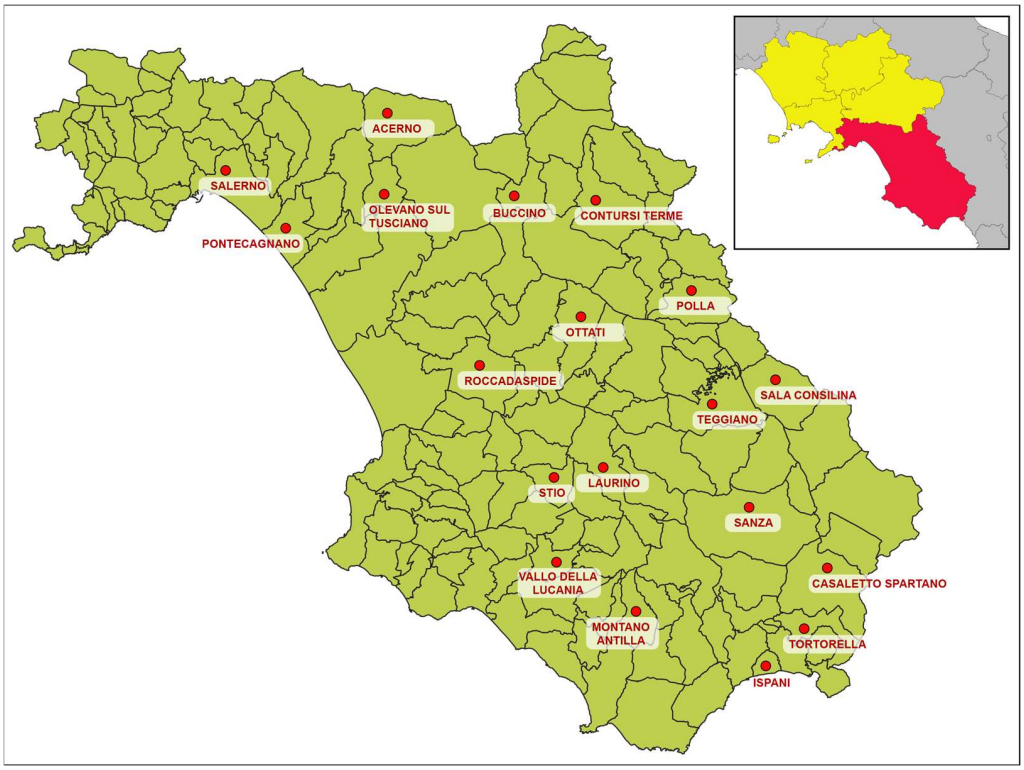

Figure 3. Distribution of firms' headquarters and stakeholders' workplaces.

All 17 firms belong to the Regional Register of Campania Forest companies and have their headquarters in the province of Salerno. Among them are, as follows:

- In total, 15 forest firms operating exclusively within the area of the study, in the first production phases (selection of assortments and transformation of semi-finished sawmill products); and
- 2 exclusively working in wood processing, thus possessing extra-regional wood as raw material.

Half of the firms work exclusively in the forest-wood supply chain, while the other half, to a lesser degree, are committed also to complementary activities. The most common assortment produced by the entire sample of firms consists of firewood and other combustibles, such as pellets. Fifteen firms produce rough wood or semi-finished products, such as poles and sawn; 4 of them produce packaging material and pallets; 3 of them produce assortments destined for the construction market (e.g., beams and matchboards); only one firm reaches the end market in the furniture sector. While the wood commercialized by the 17 firms is mainly local, the end market is mainly national, and only to a lesser degree regional and provincial. Three firms own production chain certifications, such as PEFC CoC (ITA 1002:2020) (Chain of Custody of Forest Based Products) and ISO 9001:2015 (Quality management systems). The annual average revenue varies from EUR 10,000 to more than EUR 1 million, while the net income is approximately EUR 40,000.

Among the 12 key informants there are, as follows:

- 7 self-employed forestry technicians who work in the Salerno area and are members of ODAF—Ordine dei Dottori Agronomi e Dottori Forestali of the Salerno province (the main Italian professional association of agronomists and forestry professionals);
- 4 regional functionaries; and
- 1 member of a forest-wood sector association.

2.3. Data Collection and Analysis

A semi-structured questionnaire (available upon request), was administered to the 29 participants through face-to-face online interviews, in the period October–November 2020. Interviews lasted approximately 30 min and, to avoid biases, environmental elements were kept constant, such as the same office with same orientation, same interviewer, and same dressing code. Open questions were asked, giving respondents some freedom on the focus of their answer, in line with the semi-structured modality chosen.

The questionnaire aimed to identify the following:

- strengths, weaknesses, opportunities, and threats (SWOT analysis) involved in the transition into a sustainable circular bioeconomy in the Salerno area; and
- most suitable strategies to foster the transition.

The questionnaire was composed of 3 sections, preceded by an introduction. The introduction aimed to obtain the participants' informed consent, to provide them with a brief description of the purpose of the study, as well as to introduce potential CBE solutions for the forest-wood supply chain. The two categories of respondents were asked to answer the same questions. However, the protocol was drafted in two versions, having slight differences that aimed to tailor the questions to the different respondents' role. More specifically, the entrepreneurs' version of the protocol aimed to receive answers related to their perception of the forest-wood sector of the Salerno province, considering their active role as supply chain producers, as well as their mode of operation in the management of their business; in the key informants' version, questions were phrased to receive respondents' perception of the state of the sector, considering their role as actors knowledgeable of supply chain dynamics.

The sections are the following:

- Section 1: this section aimed to gather general information on the destination of wood waste and by-products in the Salerno area, according to respondents' knowledge (Figure 4). Even though it was insufficient to have a representative and accurate outline of the current state of CBE in the Salerno province, this section provides a stylized description of the territory. Furthermore, it served as an interview warm-up to lead respondents toward the main content of the study.
- Section 2: this section was devoted to the SWOT analysis, thus including open-ended questions aiming to identify interviewees' opinion on the strengths, weaknesses, opportunities, and threats involved in the implementation of circular bioeconomy models. The SWOT analysis—also called SWOT matrix—is a strategic planning and strategic management technique intended to identify the internal (strength and weaknesses) and external (opportunities and threads) factors that are favorable and unfavorable to achieving the objectives of a venture or project [7,47–49]. Thus aimed at situational assessments, the SWOT analysis is a widely adopted tool for addressing complex strategic situations, by reducing the quantity of information and thus facilitating decision-making [50]. Performed to gain an in-depth understanding of the baseline conditions of the forest-wood sector of Salerno, the SWOT tool was selected in the present study to disentangle all the factors influencing the transition into a circular bioeconomy in this territory.
- Section 3: This section of the questionnaire was built by adapting the 19 strategies identified by Falcone et al. [7] for the transition into a forest-based bioeconomy in Italy. This contribution was selected because the strategies it suggests are based on a review of publications focusing on forest governance in Italy over the past ten years and then validated by experts in the field. By merging and synthesizing these strategies to tailor them to the Salerno context, 9 strategies were generated. Interviewees were asked if they were aware of the implementation of the strategies in the Salerno territory; then, using a 7-point scale anchored in the middle (1 = not useful at all; 4 = neutral; and 7 = extremely useful), they provided a personal assessment of the appropriateness of the strategies to nurture the transition into CBE in the forest-wood sector of Salerno.

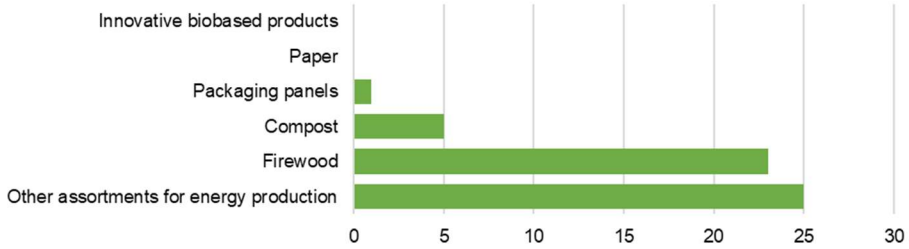

Figure 4. Destinations of wood waste and by-products in the Salerno province (N. of respondents).

Qualitative data generated through the open-ended questions was transcribed after the interview and the text was coded for interpretation and synthesis. Critical thinking during the data analysis was supported by the constant comparative method, namely, beginning with a small set of interviews (thus defining preliminary themes and concepts), and then progressing by enlarging the data corpus with more interviews.

3. Results

3.1. SWOT Analysis

This section summarizes the outcomes of the SWOT analysis (Figure 5). Single subsections are devoted to each element of the SWOT, namely, strengths, weaknesses, opportunities, and threats involved in the transition of the forest-wood sector of the Salerno province into a circular bioeconomy.

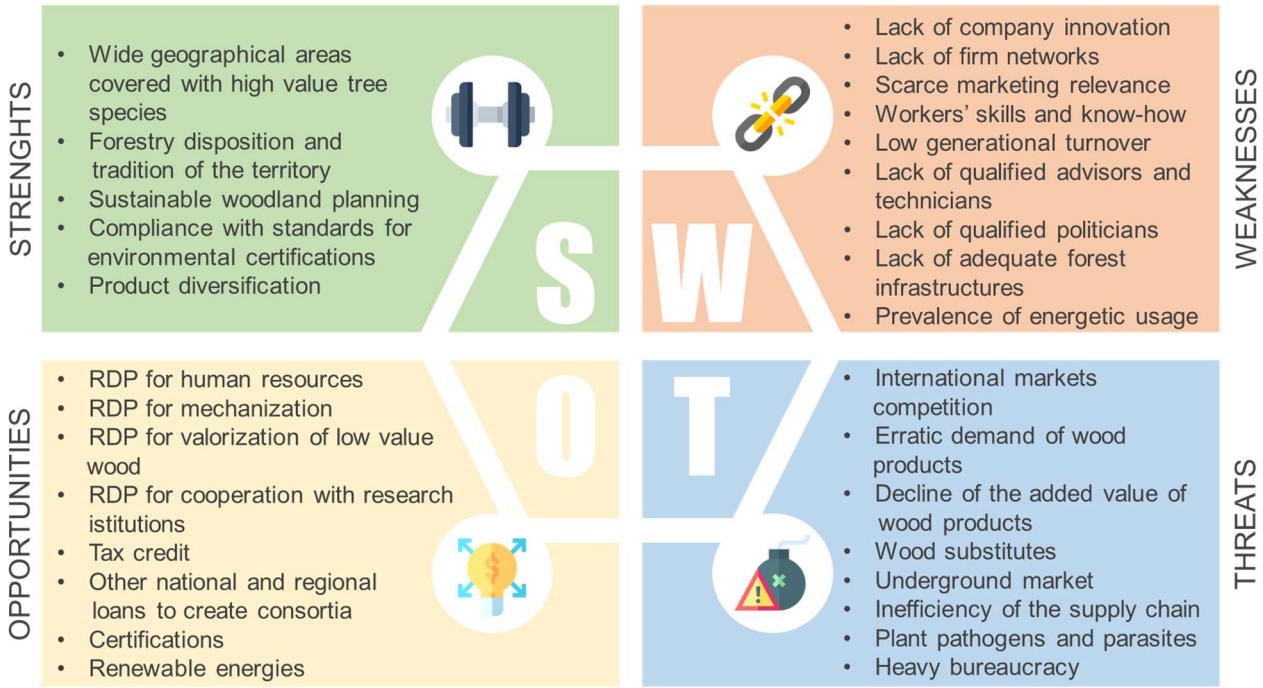

Figure 5. Summary of the SWOT analysis. Notes: RDP = Regional Development Plan; Icons are courtesy of Freepik: https://www.flaticon.com/authors/freepik (accessed 10 November 2022).

3.1.1. Strengths

There is agreement among respondents that the relevance of the forest-wood sector for the Salerno area is of paramount importance for the future implementation of CBE strategies. In a nutshell, interviewees summarize the strengths of the area for the CBE transition in its geographical extension, forestry vocation and tradition of the forest-wood sector, as well as its established industry.

The Salerno province possesses a considerable extent of wooded areas, also showing a high diversity of tree species. The botanical portfolio of the area includes species with good technological characteristics, mainly in the form of monospecific forests, that allows the production of quality raw material. Particularly relevant examples are beech (*Fagus sylvatica*), chestnut (*Castanea sativa*) and turkey oak (*Quercus cerris*). This is in line with the Italian national context, where the rich natural heritage, extended wooded area, and the great availability of wood resources, might be crucial for the future development of the sector. In the words of one of the stakeholders:

> *"The sector's strengths certainly include the considerable land area and biomass available [. . .] Furthermore, many forests in the area are mono-specific and this can foster the creation of well-structured supply chains focused on the technological characteristics of a species, such as beech or chestnut".*

The availability of economically relevant resources is accompanied by the regular uptake in the Salerno province of sustainable woodland planning, with high compliance with standards for environmental certifications. Due to their ability to absorb and store CO_2 in wood, forests play a key role in the fight against climate change, thus making the adherence to environmental certification schemes a useful strategy in order to increase future market opportunities for firms operating in the sector.

As the Salerno area has a natural vocation for forestry activities, several forest-based companies are run by the third generation of entrepreneurs. In addition, these companies hold the highest share of forestry activities in the Campania region and are the largest and most organized fims, thus representing the driving force of the regional forest-wood sector. It is no coincidence that the Salerno province hosts the headquarters of the regional association of forestry companies of Campania (ARIFC), as well as most of its members. In this context, Salerno forest-based companies rely on a solid main market, made up of historical and reliable clients, also including rooted relationships in other Italian regions. One of the entrepreneurs stated the following:

> *"One strength is the local forestry companies. I represent one of them. We have a long experience behind us, passed down through numerous generations. For example, my company is currently run by me and my brothers, but it started three generations ago, and will involve future generations, because my son and nephews have already been operating there for a few years. By the term 'experience', however, I do not only refer to the professional skills acquired over time, but also to the knowledge of the area in which we operate and the long-standing relationships with local workers. All these elements are crucial for the production process in this sector to continue, but more importantly to continue to grow".*

Therefore, as a potential consequence of the long-lasting forestry tradition in the transition into circular bioeconomy strategies, firms may be strong enough to diversify their activities and devote future investments to secondary markets related to CBE. This is confirmed by the presence of enterprises operating not only in forest harvesting, but also endowed with sawmills for first processing, as well as specialized in subsequent stages of the wood supply chain. Among the goods produced in the territory, either for other businesses or for consumers, we can mention the following: poles, strips, and beads for carpentry; beams for the construction industry; planks for the furniture and packaging sector; and firewood, pellets and wood chips for energy use.

3.1.2. Weaknesses

Weaknesses of the forest-wood supply chain of the Salerno province for transitioning into CBE are in line with challenges faced by the sector at national level. These weaknesses concern the following: company innovation, cooperation, and marketing; human resources at entrepreneurial, advisory, and institutional levels; geomorphological and infrastructural constraints.

As for the company domain, respondents highlighted the low propensity of business actors to embrace innovation, with a prevalence of obsolete harvesting and processing methods and equipment; this is also reflected in the type of products offered. In addition, the lack of a network and of articulated collaborations between both public and private forest owners, and between forestry and other businesses, is considered a structural limitation of the Salerno territory in fostering CBE innovation. According to one of the stakeholders:

> *"Unfortunately, companies do not network, they take their products out and do not create a real supply chain. There are no furniture factories in the area or structured construction companies to use local wood, and this is worsened by the lack of mechanization and process innovation".*

In line with this, one of the entrepreneurs stated the following:

> *"I would like to get active in innovative wood waste recovery, but the [. . .] lack of stable local partnerships leads me to not grow the company as much as I would".*

As forest CBE requires that wood waste becomes a shared resource among different actors, its recycling processes are inherently based on joint activities and objectives. This weakness is accompanied by the fact that product marketing is scarcely considered in the business models of forest-based firms, potentially hindering the future commercialization of products coming from novel CBE supply chains.

The backwardness of Salerno forest-based firms in terms of process, product, and business model innovation hampers also the know-how and capabilities of workers in the sector. For example, there is a lack of workers able to use advanced tools and machineries, as well as of personnel with the skills to cope with a more complex and diversified business environment. On top of that, the decreasing number of enterprises has contributed to a sharp reduction in manpower and interest in the sector by younger generations, resulting in a rise in the average age of operators. This trend is consistent with other Italian contexts, where the marginal role of forest-wood supply chains, compared with other sectors, strongly conditions the number of firms and employees. All these factors contribute to respondents' complaint about the steady increase in the direct use of wood for energy production only. According to respondents, promoting innovative CBE value chains can be instrumental in preventing younger generations from leaving disadvantaged forest areas and preserving local manufacturing traditions. For example, forest by-products can be valorized within short supply chains as an input of traditional handcrafting, in which some Italian areas stand out and present interesting peculiarities.

Respondents highlighted also that the limits of the Salerno territory, in terms of human resources ready to foster the transition into CBE, refers also to other spheres. More specifically, there is a shortage of highly qualified professionals, among advisors and technicians, as well as in the context of public institutions. As for the latter, government officials often lack subject matter expertise regarding CBE. Unfortunately, this barrier is common in the Italian context, where the forest-wood sector is hindered by inconsistencies in the policy framework, misalignment of financial instruments, and poor governance.

Lastly, all interviewed entrepreneurs and most stakeholders stressed the challenges generated by the lack of adequate forestry infrastructures in the Salerno area, where woodlands mainly exist in mountain forests. With other Italian forests sharing the same geomorphological features, if this territory was equipped with the sufficient infrastructure to access inland forested areas, it could generate much more usable biomass. This consideration, also emerging in other Mediterranean countries, has raised scientific and policy interest, at the European level, in more technological forests; this paves the way for the development of innovative wood-based value chains.

3.1.3. Opportunities

Respondents identified opportunities for the CBE transition mainly in policy and institutional external factors, such as government funding. However, market instruments, such as certifications and technological factors, were also considered important.

In particular, they pointed out the role of specific measures in the Rural Development Plan (RDP) of the Campania Region, in order to foster human resources development, innovation processes, and products valorization, as well as to increase company revenues. As for human resources, RDP considers the training of entrepreneurs, workers, and other technical experts to be of crucial importance for the development of disadvantaged forest areas. Therefore, it subsidizes the organization of courses focused on improving the skills and know-how of these professionals. RDP is also a potential funding source for renewing machineries for forest harvesting (e.g., cableways for transportation in mountain areas) and wood processing.

> *"I am sure that funding courses aimed at training entrepreneurs and workers in the sector is very useful, even more so if the subject of the training concerns process innovation and the valorization of waste products along with an incentive for the purchase of innovative machinery and/or equipment".*

Interviewees highlighted that RDP and tax credit, if combined as a synergic funding source, may be of paramount importance to nurture mechanization processes in the supply chain, thus increasing the volume of harvested biomass. In particular, volumes would be also increased by the contribution of lower value materials, such as small branches and treetops, that may be used in novel production processes. If this happened, the forest-wood sector of more disadvantaged areas would be substantially sustained; there would be a decrease in production costs and occupational risks, as well as an increase in raw materials. Lastly, respondents highlighted the future role of RDP in supporting innovation processes by designing specific interventions that would entail the collaboration of universities and other research institutions. Besides the role of RDP, other opportunities may come from national and regional loans, aiming at the establishment of forestry associations and consortia. The emergence of forest consortia could be the first step in the establishment of networks of structured intra and intersectoral structured collaborations, fundamental for the future of a forest-based CBE. The fact that combining a set of funding measures would be crucial in low profit woodlands is the main insight that emerged regarding the role of policy support. This is particularly true in the case of young forest surfaces covered with low-income species and destined to the thinning forest process. In these areas, the contribution of new technological equipment and skills, and of increased wood volumes, may feed circular bioeconomy processes and the production of innovative materials.

Even though their role was mentioned in fewer interviews, forest certifications were also considered by respondents as a potential support tool for the creation of CBE forest-wood supply chains. More specifically, the Sustainable Forest Management (GFS) and Chain of Custody (CoC) certifications may increase the added value of forest-based products, thus opening doors to international markets and providing more jobs. In the words of one of the stakeholders:

> *"Forest certification are an opportunity to get companies into markets where the quality of wood products is more relevant. Our forests are already sustainably managed; thus, it would be easy obtaining this type of certifications. Certifications might also be a first step to enter voluntary carbon credit markets".*

As the last opportunity identified, several professionals and entrepreneurs stated that the market offers a set of technological solutions to reduce energy costs by adopting renewable energies. Among these solutions, wood waste itself can be also a potential energy source to reduce the operational costs of harvesting and wood processing.

3.1.4. Threats

The respondents' focus on the threat domain consisted mainly of market factors undermining the revenues of forest-based firms. The major threat identified by respondents for the transition of the forest-wood sector of the Salerno province into CBE is the competition of foreign products in national and international markets. This challenge is a structural characteristic of the Italian forest-wood sector. However, the competition of

foreign products has worsened in recent years; this is due to the emergence of pellets as an energy source for domestic heating and the consequent decline in the market for locally produced firewood. Interviewees also highlighted an erratic demand and a generalized decline over the decades of the added value of forest-wood supply chain products, in part due to the presence of numerous substitute materials. According to respondents from both categories, another major threat to the sector is the widespread underground market, due to a population of small firms performing illegal market transactions. Besides undermining workers' conditions-with low wages, inappropriate insurances, and absent social security contributions, these companies affect the market prices of forest-based products, thus having a negative economic impact on regular businesses and forest owners. According to one of the entrepreneurs:

> *"The informal economy is widespread and, along with international competition, is an obstacle to the development of the sector. For example, my prices for small woodland owners cannot be competitive compared with those of some guy not owning a VAT number, as his costs are far lower than mine (such as insurance, social security, and other taxes)".*

Some entrepreneurs complained also of some aspects concerning supply chain organization. Specifically, it emerged from the interviews that the purchase of certain wood assortments requires too many transactions, even without the steps in which wood undergoes further transformation.

Phyto-pathological threats also affect the forest-wood sector, also due to harm engendered by international trade and climate change; these are currently problems that transcend national borders. Lastly, respondents complained about heavy bureaucracy, and increasing rules and constraints with rising administration costs; these have contributed to a reduction in firm competitiveness in the sector. As for this, one of the stakeholders said:

> *"Lack of infrastructures is a weakness in the sector. This is worsened by the incompetence of some public officials in charge of authorizing their construction, which extends authorization times, sometimes creating ridiculous obstructive mechanisms, posing serious threats to the local forestry economy".*

3.2. Strategies for Transitioning into a Circular Bioeconomy

This section aims to answer the second research question. It illustrates the outcomes of the respondents' perceived usefulness of strategies for the implementation of circular forest bioeconomy models in the Salerno province. Almost all the respondents considered the listed tools or initiatives very or extremely useful, resulting in an average score higher than six for all the strategies (Table 1). Interviews show different perceptions among the two categories of respondents, regarding the most suitable strategies to foster CBE transition. More specifically, company representatives' preferred strategies are product valorization through environmental sustainability and origin certifications, and the improvement of forest infrastructures. The frequency of this response in the SWOT analysis also showed that forest infrastructures are of crucial concern for entrepreneurs, as they are considered a dismal weakness of the forest-wood supply chain of the Salerno province. Conversely, according to the key informants, the initiatives ranking in high position and thus deserving public support are the following: training activities to promote entrepreneurship among forestry professionals, and networks between forestry and other companies aimed at promoting technological development, competition in international markets, and lobbying with political actors. Lastly, it is worth stressing that 88% of entrepreneurs and 100% of key informants gave a positive score for the need to establish new intra and intersectoral collaborations to foster technological development, competitiveness in international markets, and lobbying. Table 2 shows a list of the respondents' statements, justifying this result with the perceived functionality of the structured network and cooperation for the CBE transition.

Table 1. Rating of strategies for CBE transition.

Strategy	Score (Range 1–7)	Preferred by Entrepreneurs	Preferred by Key Informants
Planning instruments to improve forest infrastructures and increase the attractiveness for private investments (e.g., to give access to forest areas scarcely exploited due to inaccessibility)	6.6	X	-
Support training programs to promote entrepreneurial skills of forestry professionals	6.5	-	X
Instruments promoting innovative forest-based value chains	6.5	-	X
Networking among firms of the forest-wood supply chain and other sectors to foster technological development, competitiveness in international markets, and lobbying (Network strategies)	6.4	X	X
Strategies for cooperation with research institutions and promoting innovation, also aimed to implement new business models (Innovation strategies)	6.4	-	-
Actions to valorize products, such as certifications for social and environmental sustainability, promoting the local forest-wood supply chain, or "made in Italy" (Market strategies)	6.4	X	-
Planning tools defining feasible methods to reuse/recycle wood waste and by-products	6.3	-	-
Other training programs for rural populations and forestry professionals (Education strategies)	6.2	-	-
Innovation in policy, regulation and administrative instruments (Policy/Legal/Administrative strategies)	6.2	-	-

Table 2. Motivations to support network and cooperation in the Salerno province.

Category of Respondent	Motivation
Entrepreneurs	• "increasing the added value of by-products" • "benefiting new customers, and thus being of a larger market" • "since collaborating is important" • "safeguarding the future of the company" • "having new relationships, and thus new market outlets" • "for further learning and training, which are essential to growing as a company"
Other stakeholders	• "enhancing the economic and environmental sustainability of the supply chain" • "achieving the best development of the companies" • "as it is fundamental for the growth of the sector" • "improving the supply chain" • "as it is important to restore supply chains that have been lost and that should be structured by territorial districts" • "as it is advantageous" • "generating alternative market outlets and increasing profits" • "increasing the value of local products" • "as it represents a way to create innovative supply chains" • "as it is certainly useful" • "stimulating a circular economy and thus creating synergies useful for the development of the area"

4. Discussion

In recent years, the interest in renewable materials and biobased products has increased, due to the depletion of fossil reserves and critical elements, rising and volatile

resource prices, and environmental problems such as global warming and ecosystem services erosion. Among the biomass types that can be used within CBE transition pathways, wood can offer remarkable opportunities, due to the volume of waste and by-products generated along forest-wood supply chains and its varied technological outlets. Indeed, wood is an abundant natural and renewable material, which contributes to reduce greenhouse effect by absorbing and durably storing CO_2, and whose compounds may represent an input source for innovative products in the future. Besides its applications in low technology traditional handcraft, wood waste may substantially contribute to the CBE through the activation of virtuous up-cycling and cascading processes, following the biomass value pyramid principles [5]. Accordingly, chemistry research is putting strong emphasis on the evaluation of wood as a source of polymers and molecules [16]. To illustrate, wood waste may be a valuable resource in the creation of innovative materials: bioplastics [2]; LED screens and 3D printers based on cellulose nanomaterials [51]; pharmaceuticals, biolubricants and bio-solvents based on lignin [52]; and glues, foams for thermal and acoustic insulation, various adsorbents for the treatment of wastewaters contaminated with heavy metals, dyes, surfactants, and for tannins-based air pollution control [16].

Based on this potential, the latest circular bioeconomy policies suggest the application of advanced technological processes in order to upcycle biobased materials, to innovate the forest-wood sector, and to prepare it for future environmental and economic challenges. However, adopting CBE strategies in forest-wood supply chains is doomed to face several barriers in contexts that lack proper resources and a suitable business environment. The current study has sought to obtain an insight into the potential of future CBE avenues in disadvantaged Italian forest areas, with an analysis based on key informant interviews in the Salerno province. By means of an inductive process, the investigation led us to discover main strengths, weaknesses, opportunities, threats, and the most suitable transition strategies to implement CBE models in the territory at hand. Findings have shown that the Salerno area is believed to own a set of beneficial structural assets to build upon for innovating the forest-wood sector. The well-established position of the sector in the traditional local economy, also due to natural peculiarities, such as the presence of wide geographical areas covered with high-value tree species, make the Salerno territory an appropriate context in which to invest and innovate. This is accompanied by the fact that sustainable woodland planning and a high compliance with the standards for environmental certifications may be a managerial background for the economic valorization of the products of the territory. More specifically, products coming from novel CBE strategies could benefit not only the market interest for circularity, but also benefit attributes related to the virtuous stewardship of local forest areas. External policy and institutional factors, particularly related to RDP funds and other financial resources, may also support local actors to create the fundamental assets required for the CBE transition, such as well-trained human resources, advanced technological instruments, and structured collaborations among business actors and research institutions.

Despite the assets and prospects mentioned above, the Salerno province is far from having started ideal CBE pathways that are able to maximize the economic value of wood waste. Thus, the Salerno province shows shortcomings similar to other Italian territories, as well as to other disadvantaged forest areas. In these contexts, the forest industry is slow to accommodate and integrate research advancements, as investments in technological and organizational capabilities for wood waste valorization are prevented by high capital requirements and inadequate institutional support. As a result, the forest residue value chain is still underdeveloped. In particular, the forest-wood sector of the Salerno province has, in recent years, seen the devaluation of the economic potential of wood resources, due to their increasing adoption only as fuelwood for energy purposes. Somewhat ironically, it is not only wood residues that follow energy valorization, but main assortments are often also degraded in this direction. This can be explained by factors detected in the interviews and observed in other geographical areas of Italy [7]; these include the following: the poor organization of the wood supply chain; inadequate

training for rural populations in mountainous areas; insufficient investment in forest use and production; and complexity of the national and regional regulatory framework [53]. These limits are accompanied by several other internal and external constraints, hindering the propensity of local actors to innovate (e.g., low generational turnover), the logistic feasibility of raw material transportation (e.g., lack of adequate forest infrastructures), the implementation of adequate policy support actions (e.g., lack of qualified politicians), and company financial results (e.g., erratic demand and decline of the added value of wood products, harsh international market competition, and the underground market).

5. Conclusions

The current study confirms the crucial role of decision makers to create a policy and institutional background able to foster private actors to engage in the CBE transition. In the interviews, the role of the public sector to patronize investments and stimulate improved know-how and cooperation emerged as a burning issue among practitioners of the forest-wood sector. In addition, and in line with a more general limitation of closed loop strategies for biomass valorization, the forest-wood sector also suffers from regulatory inconsistencies. One example is the case of subsidies for wood waste incineration, which clearly acts contrariwise to the need to create incentives for upcycling and cascading processes.

The current state-of-play makes evident the need to design synergistic innovation pathways between firms of the forest-wood sector and research institutions. Forest residues have very high potential, which can be realized if research progresses in this area are followed by capacity building and technology transfer at the practitioners' level. To summarize the most pressing innovation pathways to follow, future research and practice implementation should focus on new solutions to reduce forest waste by improving traditional harvesting techniques, as well as delve deeper into material sciences to develop new CBE products. Moreover, research and firms' efforts, focusing on technological advancements, should be accompanied by proper business model adaptations that concern product valorization at the market level. An appropriate marketing endeavor will be crucial to transforming the highly environmentally sustainable production of disadvantaged forest areas into an actual competitive advantage in the market environment.

Author Contributions: Conceptualization, M.B. and E.A.; Methodology, M.B. and E.A.; Investigation, M.B. and E.A.; Resources, E.A. and L.C.; Data Curation, E.A.; Writing—Original Draft Preparation, M.B., A.L. and V.D.; Writing—Review and Editing, M.B. and L.C.; Visualization, M.B. and V.D.; Supervision, M.B. and L.C.; Project Administration, L.C.; Funding Acquisition, L.C. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the Italian Ministry of Education, University and Research (MIUR) within the project PRIN DRASTIC "Driving The Italian Agri-Food System Into A Circular Economy Model," PRIN-MIUR—Call 2017.

Institutional Review Board Statement: In our institution these kind of studies do not require ethical approval as complying with the Declaration of Helsinki.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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

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