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Forest Company Dependencies and Impacts on Ecosystem Services: Expert Perceptions from China

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Abstract: Global awareness of sustainability issues is growing rapidly, and business organizations are called to address wider social and environmental concerns along with economic performance. However, limited systematic knowledge exists on the interactions between forest industries and natural ecosystems. We thus investigated the role of ecosystem services in the context of China's forest sector. A qualitative research approach was used to elicit company external expert viewpoints on the topic. Our analysis focused on three themes: (1) forest company dependencies and impacts on ecosystem services; (2) business risks arising from dependencies and impacts; and (3) risk response strategies. The interviewed 20 experts identified a series of forest company dependencies and impacts (including negative and positive impacts) on several ecosystem services. The extent of dependencies and impacts is largely influenced by the business portfolio of the company. The perceived business risks include intense competition and the consequently increasing price for natural resources, which would affect forest company business plans, costs and outputs. The suggested strategies for turning risks into opportunities include outsourcing wood, changing production focus, promoting industrial upgrading and implementing regular assessments of corporate dependencies and impacts on ecosystem services. The findings of our study can guide companies' decision-making in managing forest ecosystems sustainably.

Keywords: forest company; ecosystem services; dependency; impact; expert perception; China

1. Introduction

Achieving sustainability is today's major challenge facing global society [1]. Over the past few decades, demographic and economic growth has created unprecedented demand for food, energy, timber, water and other ecosystem services, simultaneously placing greater pressures on the natural environment. The attention of governments and the scientific community has thus been turned to ecosystem condition and services, as these largely determine the sustainability of economic development and social progress [2–4]. With a growing scientific and policy interest in sustainability, ecosystem services have become a crucial and central topic of research at the interface of economic, social and natural systems [5–9].

By definition, ecosystem services are the benefits that people obtain from ecosystems, and these benefits are commonly classified into four categories: provisioning services, regulating services, cultural services and supporting services [2]. According to Millennium Ecosystem Assessment (MEA) [2], provisioning services are material outputs from ecosystems, including food, fresh water, fuel, fiber, genetic resources, wood and non-wood forest products; regulating services include local climate and air quality regulation, carbon sequestration and storage, water purification and environmental

hazard (e.g., pests, disease, flood and erosion) control; cultural services refer to aesthetic, spiritual and recreational benefits; supporting services ensure basic ecosystem functions such as the production of biomass and oxygen, soil formation and retention and nutrient cycling.

The concept of ecosystem services has evident implications for the private sector [10]. Around the globe, companies are increasingly integrating sustainability into their business strategies by means of corporate social responsibility or corporate sustainability, which is a business approach whereby companies contribute to sustainable economic development by integrating social and environmental concerns into their business operations through the interaction with their stakeholders [11,12]. Because companies depend on and impact ecosystem services [13,14], business management should also integrate ecosystem services into their long-term strategy and operations [15].

As a natural resource-intensive branch, the forest industry relies on a variety of ecosystem services and underpins biodiversity to ensure successful operations [16–18]. This offers a solid research setting for investigating how forest companies should control their dependencies and impacts on ecosystem services in a changing environment [19,20]. As one of the fastest-growing economies, China plays a major role in the global forest sector [21]. By far, the country is the world's largest producer and consumer of wood-based panels and paper along with being the largest exporter and importer of wood-based panels and industrial roundwood and sawnwood, respectively [22]. The rapidly developing forest industry in China requires large amounts of natural resources such as land, water and timber. However, excessive timber exploitation and unsustainable use of forest resources by forest companies have caused ecosystem degradation throughout the country [23,24], which has seriously hindered the sustainable development of China's forest industry. Over the past few decades, Chinese forest companies have been under increasing pressures from both local- and global-level stakeholders to reduce their negative impacts on ecosystem services [25–27]. Control over environmental issues, such as climate change and water pollution, have progressively become key strategic variables for companies [28,29].

To provide a resource base for high demand for wood products, pulp and paper while simultaneously addressing ecosystem degradation, the Chinese government has undertaken a set of massive policy initiatives to protect the country's forests and expand commercial plantations [30,31]. This has led to a rapid increase in the plantation area in southern China, particularly of fast-growing species such as *Eucalyptus*. China currently has the largest plantation area in the world, accounting for 38% of its total forest area [32]. Over the past few years, several domestic and international companies have invested in plantation forestry in southern China [33]. However, so far, it has not yet significantly improved the timber supply situation with respect to the emerging domestic forest product industries [24]. Instead, the expansion of *Eucalyptus* plantation forestry has elicited environmental concerns related to increased consumption of water and reduction in biodiversity, along with social disputes between companies and village collectives about land lease arrangements [34]. These issues have become very pressing for forest companies' local operations, especially given the pressure and expectations of local communities and authorities, non-governmental organizations (NGOs) and researchers.

Company stakeholder perceptions of environmental issues are often analyzed in the literature to support deeper understanding of corporate sustainability dynamics [35–37]. However, the literature dealing with company stakeholder perceptions of ecosystem services, especially in the context of China's forest sector, is still scarce. The purpose of this study was to examine stakeholder perceptions of the interactions between forest companies and ecosystem services in China. Our analysis focused on the following three themes: (1) forest company dependencies and impacts on ecosystem services; (2) business risks arising from dependencies and impacts; and (3) risk response strategies (i.e., strategies for turning business risks into opportunities).

Given the innovative and explorative nature of this study, we employed a qualitative research method and attempted to generate deep insights into a phenomenon that has been poorly investigated in previous literature. We targeted our interviews at the stakeholders characterized by a broad technical knowledge of China's forest sector, who were regarded as experts in our study. These stakeholders were

engaged in and/or influenced the decision- and policy-making processes locally and regionally, but without being directly involved with company activities, so they were categorized as company external stakeholders. According to the stakeholder theory [38], a stakeholder is “any group or individual who can affect or is affected by the achievement of the organization’s objectives”. Stakeholders include internal stakeholders, such as employees and shareholders, and external stakeholders, such as suppliers, customers, competitors, governments, civil society organizations, local communities, the general public and the media.

The value added of the present study is that it prompts ecosystem services thinking within a business organization context, which has been identified as a critical research gap in sustainability and ecosystem services research [39]. This study was designed as a part of a triptych together with another two studies dedicated to assessing the views of company managers and local communities, respectively [37,40].

2. Literature Review

The ecosystem services concept emphasizes the importance of natural systems to human society and the economy [3,7,8]. Whether ecosystem services have commercial value or not, they underpin several economic sectors globally. Previous literature [13,14,41] has pointed out that businesses, stakeholders and ecosystems are deeply interlinked. Companies exercise positive and negative impacts on natural ecosystems and their services. Simultaneously, companies also depend on ecosystem services, including natural resources and the buffering capacity of ecosystems.

Forest companies, on the one hand, depend to a large extent on ecosystem services that provide them with raw materials for final products (e.g., timber), support manufacturing and extraction processes (e.g., water availability), maintain system productivity (e.g., pest and disease control), mitigate risks (e.g., floods and storms) and offer intangible benefits (e.g., aesthetic enjoyment and recreation); on the other hand, they impact ecosystem services through their operational activities, such as the usage of ecosystem services as inputs for their operations (e.g., water, timber and genetic resources), the outflow of by-products into the natural environment (e.g., emissions, waste and effluents) and other activities that result in ecological changes (e.g., the introduction of invasive species) [15,42].

Such strong dependencies and impacts may lead to the materialization of business risks. For instance, forest company dependencies on wood and other natural resources expose them to the risks of increasing prices and intense competition for raw material supply. In response to these risks, forest companies can seek new opportunities by implementing effective strategies. Conceptual and empirical evidence from scientific literature suggests that to be effective, businesses should integrate sustainability principles into their corporate strategy [43–45].

In this context, stakeholder expectations and perceptions can provide important insights into corporate sustainability, and their valuable perspectives may be incorporated into companies’ decision-making process. Because the relationships between companies and their stakeholders are fundamental for corporate social performance [38,46], understanding and meeting stakeholder needs contributes to companies’ social license to operate [47–49].

To survive, thrive and gain acceptance, companies must take actions to support the claims of their stakeholders [50], who play a key role in contracting the ethical identity of corporations [51]. By imposing a set of expectations and standards, stakeholders can provide companies with legitimacy and operating licenses [52]. Furthermore, perceptions from the relevant company stakeholders, especially those experts with in-depth knowledge of the industry, can provide profound insights into the environmental issues and related business risks and opportunities that companies are facing [53]. Previous literature has highlighted the importance of stakeholder involvement in managing complex environmental issues, improving corporate legitimacy and promoting proactive environmental strategies [54]. Nowadays, the role of stakeholder engagement is also growing in emerging countries like China. In such contexts, stakeholders’ perspectives are particularly pressing for international companies. In stakeholders’ opinion,

compared with managers from domestic companies, managers from international companies operating in China were more aware of risks [37]. International companies are generally found to adopt proactive environmental strategies [55]. However, such strategies might not be completely fine-tuned with the sustainability challenges specific to the country where they operate [56].

3. Materials and Methods

3.1. Data Collection and Study Area

Qualitative research has been broadly used in organizational research to access people's experiences, perspectives and attitudes because this approach enables in-depth analyses of people's views [57,58]. We therefore employed a qualitative research approach to assess company stakeholder perceptions.

We collected data by interviewing forest companies' external experts with the specific technical expertise in the forest sector throughout China during the spring and summer of 2014. These experts were composed of four stakeholder groups in the context of forestry, including: (1) local authorities, such as leaders of the provincial forestry department; (2) policy advisors from academies; (3) industry associations and consultants; and (4) forest-related NGOs representing the voice of the natural environment. Useful classifications of these stakeholder groups were drawn from previous theoretical and empirical literature [36,59]. These groups were selected as the target groups for our study because of their relevance and expertise in influencing the forestry decision-making process in China's forest sector. Table 1 provides a summary of the data sample.

Table 1. Sample of expert stakeholders for the study.

Expert Stakeholder Groups	Number of the Interviewees
Local authorities	4
Policy advisors from academies	9
Industry associations and consultants	4
Forest-related NGOs	3
Total	20

A combination of purposive and snowball sampling was used to ensure that we interviewed the informants that were relevant to our study. Each interviewee would suggest one or more colleagues with rich experience and wide knowledge on the topic under investigation [58]. The informants in the sample were selected based on their willingness to participate in face-to-face interviews and their deep understanding of forest ecosystem services and policies. A total of 20 informants was interviewed, and the interviews were conducted in six different Chinese cities: Beijing, Shanghai, Wuhan City in Hubei Province, Changsha City in Hunan Province, Guangzhou City in Guangdong Province and Nanning City in Guangxi Province (Figure 1). The reason why these cities were selected was because the interviewees were located there.

The choice of performing individual interviews rather than, for example, focus groups was dictated by several issues. First, the time availability and the various locations of the interviewees would have created challenges for organizing parallel focus group meetings. Second, although focus groups capture multiple perspectives simultaneously, individual interviews ensure anonymity and a "safer" environment to discuss topics of a sensitive nature. Third, individual interviews also allow the interviewer to dedicate more time to each informant.

To help the informants familiarize themselves with the contents of our study, an introduction to the study, key concepts and the semi-structured questionnaire used in the interviews were sent to them prior to the interviews. The questionnaire comprised several open-ended questions arranged in three thematic sections: (1) perceived forest company dependencies and impacts on ecosystem services; (2) business risks arising from company dependencies and impacts; and (3) strategies for turning

business risks into opportunities. It should be noted that in the interviews, we did not explicitly provide a definition for ‘forest company’, which mainly includes, for instance plantation-based forest companies, logging companies, sawmills, pulp and paper companies and wood products companies. Even though, each interviewee was actually able to interpret the idea of ‘forest company’ based on his/her own personal experience and familiarity with the forest sector. On the one hand, this might avoid imposing pre-defined limits on the discussion; on the other hand, it might hamper complete comparability among the interviewees’ answers.

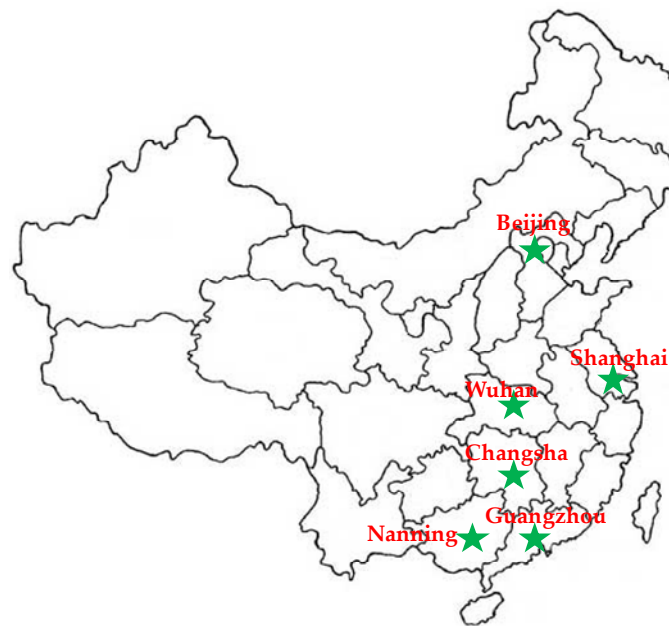


Figure 1. Location of the study areas in China.

3.2. Data Analysis

Our data analysis was based on an existing theory that describes the categories of analysis [2], as well as some available business literature that describes business risks and strategic opportunities [60]. For example, our analysis of dependencies and impacts is based on the MEA classification of ecosystem services: provisioning, regulating, cultural and supporting services [2]. The analysis process is as follows: the interview data were coded into themes; recordings of the interviews were first transcribed verbatim in Chinese; the transcripts were thoroughly read through several times, and recurrent and important words or phrases were highlighted and abstracted into concepts; categories were then created to fit the identified thematic concepts. This kind of analysis can be considered a typical abductive qualitative analysis because the data contributed to formulating our theoretical understanding of key concepts.

The codebook was built in an iterative process, moving back and forth between the data and theories. The unit of our analysis was a single interviewee. After the coding phase, the transcripts and codebook was translated into English and shared with non-Chinese speaking researchers of our team. The analysis was discussed and deepened with the support of other team members.

By going through the data iteratively and conducting data analysis, it was possible to determine at which point data saturation was achieved for the main research questions, meaning that no substantial new insights would be gained with additional interviews and there was sufficient information to reach consistency with theoretical concepts. Furthermore, according to previous research, 20 informants are typically considered an acceptable sample size to achieve data saturation [61], especially when the study focuses on well-defined research questions.

3.3. Validity and Reliability

To ensure the validity and reliability of the results of our study, several aspects were taken into account during different phases. Prior to the interviews, the questionnaire was pre-tested with research experts and modified where necessary. During the interviews, the interviewer tried to create a mutually open and honest atmosphere to ensure the receiving of all necessary information. The interviews were conducted either in Chinese or in English according to the interviewees' preference, and they were recorded with consent from the interviewees. However, to avoid possible problems caused by language barriers and to ensure the acquisition of accurate information, most of the data collection was implemented in Chinese, which is the native language of the interviewer and interviewees. Each interview lasted between one and two hours, and the identity of the interviewees was assured anonymity. Nonetheless, we cannot fully rule out the possibility for some degree of social desirability bias [62] on what the interviewed experts would like to be the case rather than what is reality. Given the heterogeneity of the stakeholder groups, however, we are confident that different views are represented in the sample, balancing each other out.

In spite of the limited sample, including geographically-restricted data from the selected expert stakeholder groups, our data were sufficiently in-depth, homogeneous and coherent, giving support to a sufficient amount of empirical content. Overall, the validity and reliability of our study results can be considered sufficient.

4. Results

4.1. Forest Company Dependencies and Impacts on Ecosystem Services

The interviewed stakeholders articulated forest company dependencies on ecosystem services only in terms of provisioning and regulating services (Table 2). Not a single interviewee mentioned examples of supporting and cultural services. Most interviewees stated that forest companies greatly depend on ecosystem services provided by forests, including land, timber, water, energy, soil and genetic resources. Several policy advisors, industrial consultants and NGOs representatives, however, pointed out that the extent of these dependencies was largely influenced by the business portfolio of the company, namely: plantation-based forest companies, pulp and paper companies and wood products companies.

Table 2. Examples of expert stakeholder perceptions of forest company dependencies on ecosystem services.

Dependencies	Stakeholders
'Forest companies, especially plantation-based forest companies, have great dependencies on ecosystem services, such as land, timber, water and energy.'	Policy Advisor 2
'The extent of forest company dependencies and impacts on ecosystem services mainly depends on the type of forest companies involved. Plantation-based forest companies have strong dependencies on, for example, local temperature, while wood products and pulp and paper companies are not so dependent on local ecosystem services as they mainly acquire timber from their suppliers instead of being involved in tree plantations directly.'	Policy Advisor 5
'Dependencies of forest companies can be described from two angles: plantation-based forest companies heavily rely on land, water, soil and genetic resources, while wood products and pulp and paper companies are mainly dependent on timber, water and wood fibers.'	Industry Consultant 1
'Plantation-based forest companies have great dependencies on local climate (in particular, temperature and rainfall), soil conditions and geographic conditions.'	Policy Advisor 8
'In addition to timber, water and genetic resources, forest companies heavily rely on soil conditions.'	Local Authority 1

Plantation-based forest companies were perceived to have great dependencies on land, timber, water, energy, local climate along with soil and geographic conditions. By contrast, wood products and pulp and paper companies were considered to be less dependent on ecosystem services, with

the exception of timber, water and wood fibers for industrial operations. This is because they mainly acquire timber from their suppliers instead of being directly involved in forestry operations.

According to the interviewed stakeholders, forest companies not only depend on, but also impact local forest ecosystem services (Table 3). However, unlike dependencies, impacts were also addressed in terms of cultural services (e.g., landscape values and recreational benefits) in addition to provisioning and regulating services. In fact, most interviewees addressed varying negative impacts caused by different types of forest companies: while improper operations of plantation-based forest companies place considerable stress on biodiversity, water (including water quality and water quantity), soil quality, land and ecosystem resilience to diseases and pests, wood products and pulp and paper companies discharge wastes (solid wastes, liquid wastes and gaseous emissions) during their industrial processes.

Table 3. Examples of expert stakeholder perceptions of forest company impacts on ecosystem services.

Impacts	Stakeholders
Negative Impacts	
'Improper operations of plantation-based forest companies negatively impact local ecosystem services, such as biodiversity, water and soil conservation capacity as well as resistance against natural disasters.'	NGO 1
'Excessive fertilization because of the tree growth-promoting actions of forest plantation companies will induce soil acidification and in turn lead to soil degradation.'	Policy Advisor 1
'Take <i>Eucalyptus</i> plantations as an example: People use double ploughing to increase productivity, which would lead to soil erosion and thus result in the loss of soil fertility.'	Policy Advisor 4
'Eucalyptus plantations may cause excessive water abstraction and also influence water quality.'	Policy Advisor 9
'Pulp and paper companies cause negative impacts to the natural environment if they do not handle wastes properly.'	NGO 1
'Wood products companies discharge solid waste during their manufacturing processes.'	Local Authority 1
Positive Impacts	
'Forest companies' plantations can beautify the environment, conserve soil and water, enhance carbon sequestration and improve the efficiency of fiber production.'	Policy Advisor 1
'Well-managed timber plantations can enhance soil and water conservation, prevent natural disasters, improve local revenue and increase forest coverage.'	Industry Consultant 1
'From the perspective of forest management, forest plantation companies' proper operations will control pests and prevent forest fires more efficiently.'	Policy Advisor 3

In contrast to the perceived negative impacts, positive impacts were only noted for plantation-based forest companies. According to a few policy advisors and industry consultants, well-managed forest plantations contribute to increases in forest coverage, efficient timber and fiber production, landscape beauty, carbon sequestration, enhanced soil and water conservation, pest control, forest fire prevention and the improvement of the livelihoods of local communities.

4.2. Business Risks Arising from Company Dependencies and Impacts

Most policy advisors and several local authority representatives expected a variety of business risks that would arise from company dependencies and impacts on ecosystem services (Table 4). According to some of the local authority representatives, climate change (e.g., abrupt changes in temperatures) and a related increased frequency of natural disasters (e.g., droughts, storms and typhoons) would bring about a series of ecosystem-related risks (e.g., insufficient supply of natural resources and increases in relevant costs) and thus pose great pressures on forest companies. This is due to the fact that the forest industry relies on the natural environment.

Table 4. Examples of expert stakeholder perceptions of business risks arising from company dependencies and impacts.

Business Risks	Stakeholders
'Because the forest industry is a natural resource-based industry, changes in ecosystem services pose great pressures on forest company business practices.'	Local Authority 1
'Changes in ecosystem services have caused intensified competition for land acquisition, timber procurement and water supply, and have thus increased the prices of land, timber and water.'	Local Authority 4
'Changes in water, land and climate will affect forest company business plans, operational costs, outputs and funding sources.'	Policy Advisor 3
'As for plantation-based forest companies, low temperatures and typhoons would harm some of their trees and hence increase some relevant costs (e.g., labor costs and logistic costs). By contrast, wood products companies are not influenced by these natural disasters so much because they acquire wood materials from their suppliers. Hence, their business risks mainly originate from markets.'	Policy Advisor 5

Based on the interviewees' perceptions, shortages of natural resources, such as timber, water and land, caused by climate change and natural disasters would lead to intense competition and higher prices for these resources. Other perceived risks included increases in relevant costs, such as labor costs and logistics costs. According to the informants, all of these elements would affect business plans, operational costs, outputs and funding sources of forest companies, with plantation-based companies being more likely to be directly affected by the perceived risks than wood products and pulp and paper companies because the latter seem to be affected by ecosystem-related risks mainly through their supply chains.

4.3. Strategies for Turning Business Risks into Opportunities

In consideration of the above-mentioned risks, our interviewees also suggested the corresponding response strategies (i.e., the strategies for turning ecosystem-related risks into opportunities (Table 5). According to several policy advisors and experienced experts from industry associations and NGOs, some risks appear to be turned into opportunities by implementing effective strategies. As an NGO representative stated, 'While some companies are facing risks due to the deterioration of natural ecosystems, others may seize new business opportunities.' In response to insufficient timber supplies in local areas, several interviewees perceived globalization as an opportunity for companies, which allows companies to import or outsource wood materials (e.g., by purchasing timber or acquiring forestland from other countries or regions). To avoid direct competition for wood caused by the deficiency of wood materials, some experts suggested that forest companies change their production focus by shifting to non-wood fiber production through the utilization of, for example, bamboo and straw. Large-scale forest companies were suggested to promote industrial upgrading from low value-added to high value-added products' production, which can be realized by investing in aggressive research and development (R&D), for example for environmentally-friendly technologies and products. Developing such technologies will lead to efficient use of wood materials (e.g., forest residues and recyclable materials), and employing new environmentally-friendly bio-technologies can optimize tree growth and survival in response to lowered productivity of planted trees caused by natural disasters.

In the face of natural ecosystem degradation, the interviewees uniformly confirmed the importance of undertaking regular and systematic assessments of corporate dependencies and impacts on ecosystem services. They believed that such assessment information would be beneficial to multiple stakeholders from different aspects, including government planning, timely changes in corporate strategy, corporate decision-making concerning products offered and rental agreements with forest farmers (e.g., leasing price and length and transferring conditions of land). According to the interviewees, assessments of company impacts on ecosystem services (including both internal

and external impact assessments) already exist in China. As a process of evaluating the possible environmental impacts of a proposed project, an Environmental Impact Assessment (EIA) is required for any company being set up in China. The EIA actually serves as an internal impact assessment system for the company, and it is based on the company's internal reports and feasibility studies and must be implemented already before any company is set up. Then, after the company is set up, its operations will regularly be monitored by the environmental protection bureau, with a focus on waste discharge. Other forms of assessments in China include standards for sustainable forest management, such as the Forest Stewardship Council (FSC), the Programme for the Endorsement of Forest Certification (PEFC) and the China Forest Certification Council (CFCC), which already obtained mutual recognition with the PEFC in 2014. These three forest certification systems can be viewed as a form of external impact assessment system for ecosystem services even though such systems do not explicitly include nor refer to ecosystem services. In contrast to internal impact assessment systems, no particular assessment procedure for company dependencies on ecosystem services exists in China yet. Nonetheless, some literature that promotes more explicit integration of ecosystem services (impacts and dependencies) into impact assessment and certification systems [63–66] exists.

Table 5. Examples of expert stakeholder perceptions of strategies for turning ecosystem-related risks into opportunities.

	Strategies	Stakeholders
Importing or outsourcing wood	'If forest companies cannot acquire enough wood materials locally, they should consider purchasing wood or acquiring forestland from other countries or regions to meet their needs.'	Policy Advisor 5
Changing production focus	'Changes in ecosystem services call for forest companies' motivation for changing their production focus.'	Industry Association 1
	'A change in production focus by shifting to non-wood forest products production would help forest companies avoid direct competition for wood raw materials.'	Local Authority 2
	'The reduction in harvest quota forces forest companies to seek for substitute raw materials or efficiently use wood materials such as forest residues and recyclable materials for production.'	Policy Advisor 8
Promoting industrial upgrading	'In addition to the risks posed by environmental changes, some new opportunities are emerging for forest companies, especially for large-scale companies, as they have the capability to optimize their industrial structure and promote industrial upgrading from low value-added products to high value-added products.'	Policy Advisor 3
	'To realize industrial transformation and upgrading, forest companies can develop environmentally friendly technologies and products.'	Industry Association 1
	'When facing lowered productivity of plantations caused by natural disasters, such as wind, typhoons, droughts and pest attacks, forest companies should employ new technologies to optimize tree growth and maximize tree survival.'	Policy Advisor 5
Implementing regular assessments of corporate dependencies and impacts	'Forest companies in China have both internal and external assessment systems. An internal assessment system is related to the Environmental Impact Assessment (EIA), which is based on the company's internal reports and feasibility studies and must be implemented before any company is set up. By contrast, an external assessment system is related to some forestry standards, for example, the Forest Stewardship Council (FSC), the Programme for the Endorsement of Forest Certification (PEFC) and the China Forest Certification Council (CFCC), which has gained mutual recognition with the PEFC.'	NGO 1
	'... After the company is set up, its operations will regularly be monitored by the environmental protection bureau, with a focus on the discharge of their wastes.'	Policy Advisor 5
	'Currently, the Chinese law does not require a specific assessment of corporate dependence on ecosystem services.'	Industry Association 2

The interviewed experts believed that the Chinese forest companies could mitigate risks and grasp emerging market opportunities domestically and internationally by implementing the above four strategies. However, when talking about the potential business opportunities arising from China's national carbon Emission Trading Scheme (ETS) for the Chinese forest companies, most of the interviewees were skeptical about it, although China's forest sector is included in this scheme. The underlying reasons include the fairly low price in China's carbon trading market, government-driven behavior rather than market-driven incentives and cross-border trade over long distances. This makes it difficult to obtain widespread recognition from either the public or the business sector in China.

5. Discussion

The results of this study indicate a fair level of recognition from company external expert stakeholders concerning forest company dependencies and impacts on ecosystem services, particularly provisioning and regulating services. It should be noted that some of the items mentioned by the interviewees (e.g., land and biodiversity) are actually the elements of natural capital rather than ecosystem services per se. According to the ecosystem literature, natural capital represents natural assets, such as soil, air, water and biodiversity [2], and it provides the biophysical setting for various ecological processes, which can be considered ecosystem services if it is relevant to human beings. For the sake of simplicity, we did not make a distinction between natural capital and ecosystem services in this article. The reason is that the interviewees were not fully aware of the conceptual nuances found in the ecosystem services literature.

The interviewees only mentioned the most relevant ecosystem services based on their own experience. Using an ecosystem services framework allows us to highlight the gaps between stakeholder perspectives and the full spectrum of ecosystem services. Importantly, the interviewed experts noted that the extent of company dependencies and impacts on ecosystem services were determined by the business portfolio of the company.

Available literature provides little information about forest company dependencies on ecosystems, as this concept has only recently emerged in grey and scientific literature. For example, the dependencies of different economic sectors were broadly assessed in *The Economics of Ecosystems and Biodiversity (TEEB)* [3,10], with a specific focus on the forest sector, as studied by D'Amato et al. [37,41]. By contrast, fairly abundant literature is available for forest companies' impacts on the natural environment, especially regarding plantation-based forestry and industrial processes [36,37,67].

In our present study, expert perceptions of company dependencies on ecosystem services were found to be consistent with what has been proposed by previous literature. For example, as stated by D'Amato et al. [37] and Wei and Xu [68], in addition to timber, forest industry production also depends on other natural resources, such as water, which is one of the primary inputs in forestry and industrial processes, together with local climate conditions, land, soil fertility and genetic resources.

Plantation-based forest companies were deemed to negatively impact biodiversity, water and soil by some of our interviewees. This finding is somewhat in line with previous literature. For instance, Gordon et al. [36] and D'Amato et al. [37,40] investigated stakeholder perceptions of forest companies' impacts on the natural environment in Australia and China, respectively. In addition, our interviewees' perceptions of company impacts are in line with some existing ecological findings. As indicated by de Wit et al. [69], Fenning and Gershenson [70] and Taki et al. [71], forestry operations often impact natural habitats and existing wildlife species, which would lead to a loss of diversity. As criticized by Jackson et al. [72] and Thompson et al. [73], fast-growing tree plantations negatively affect water resources, and their high nutrient demand affects soil chemical properties. Moreover, as found by Gaertner et al. [74], the invasiveness of commercial alien species, such as *Eucalyptus*, negatively impacts the diversity of native plants, which would lead to a risk of hybridization with native species [69,75,76]. Furthermore, as stated by Nair [77] and Walther et al. [78], plantations in the areas outside their native range might be more sensitive to pest invasions.

Notably, none of the informants mentioned company impacts on local communities, which might relate to provisioning and cultural services such as land access or customary rights issues, land use competition, as well as cultural identity and the sense of belonging associated with nature. However, these issues are very relevant for developing and emerging economies, and they have actually been reported in both the scientific literature [61] and corporate sustainability disclosure [15,79]. For example, as pointed out by Cossalter and Barr [80], cases of inequitable land lease contracts or land share agreements have been recorded in Guangxi Province in China, which may lead to growing tensions between forest companies and local communities.

In addition to negative impacts, a few experts also mentioned positive impacts of plantations on the natural environment, including increased forest coverage, efficient timber and fiber production, landscape beauty, carbon sequestration, the enhancement of soil and water conservation, pest control, forest fire prevention and the improvement of the livelihoods of local communities. Since ecological impacts of plantations are highly context-specific, the experts' statements reflect the diversity of information reported in previous scientific literature on the impacts of plantation forestry, which mainly depend on the previous land use [69,72–75,77]. The positive impacts of plantations related to timber production and carbon sequestration are consistent with the findings of Gordon et al. [36], D'Amato et al. [37] and Tian et al. [81]. In addition, in line with the findings of Gordon et al. [36] and Tian et al. [81], aesthetic values of forest landscapes arising from plantations would provide recreational opportunities.

It is noteworthy that, as observed by Smaill et al. [82] in a comparison of ecological data with a stakeholders' survey, stakeholders' opinions may sometimes be inaccurate, leading to erroneous assumptions regarding the suitability of most candidate (tree) species to deliver ecosystem services. This highlights the discrepancy between ecological limits and people's preferences and opinions [5], representing a great challenge for the decision-making on environmental governance matters.

Regarding the impacts of wood products and pulp and paper companies on ecosystem services, wastes were the only negative impact addressed by the interviewees. Although carbon emissions are certainly a relevant issue for forest companies [83,84], it is odd that this issue did not emerge from our interviewees in the context of company impacts. A possible reason is that, when being observed in its entirety, forest companies contribute to both carbon sequestration and carbon emissions. In fact, carbon emissions from forestry operations and industrial processes are usually considered a key topic in forest companies' corporate sustainability disclosure [85,86]. Voluntary corporate sustainability reporting guidelines, such as the Global Reporting Initiative (GRI), include quantitative indicators of direct and indirect greenhouse gases, ozone-depleting substances, nitrogen, sulfur oxides and others [83]. However, the interviewees mentioned the carbon issue later in the context of emerging business opportunities for forest companies.

Business risks arising from company dependencies and impacts included intense competition and the consequently increasing price for natural resources such as timber, water and land, as well as increases in some relevant costs such as labor and logistics costs. All of these elements would affect forest companies' business plans, operational costs, outputs and funding sources. According to existing literature, these risks will be intensified by climate change and natural disasters. As stated by Pawson et al. [87] and Kirilenko and Sedjo [88], increased frequency and unpredictability of natural disasters (e.g., typhoons, storms, floods, droughts, forest fires, plant diseases and insect pests) are expected to represent a great threat to productivity that will present wide regional variations, and climate change is deemed to result in higher costs of forestry operations, logistics and insurance services, as also found in our study. Other vulnerabilities might include changes in wood quality, forest fires and pest outbreaks.

Our findings concerning business risks are also in line with D'Amato et al. [37]. In addition to some similar risks perceived by both studies, the company managers interviewed by D'Amato et al. [37] were also aware of the risks related to society and transparency issues originating from local communities' opinions and pressures. This is probably because the plantation companies interviewed by them are

directly involved in forest-related activities in local regions; the relationship with local communities will therefore naturally affect their business.

In order to mitigate the perceived risks, the interviewees suggest that forest companies should carry out corresponding strategies, including importing or outsourcing wood, changing production focus, promoting industrial upgrading and implementing regular assessments of corporate impacts and dependencies on ecosystem services. In their opinion, effectively implementing these strategies could help forest companies turn those business risks into market opportunities.

To ease the problem of insufficient domestic timber supply in China, some interviewees suggested that forest companies should import or outsource wood from other countries or regions. Triggered by the Chinese government's adoption of the "Going Global" strategy in 2001, China's outward foreign direct investment (FDI) has been growing rapidly [89], but wood outsourcing has been criticized for its unethical implications. Moreover, concerns have been raised about land or property rights acquisition from international companies [90,91]. Furthermore, increased competition in global log trade and the growing importance of the transparency of the source of origin would limit China's wood imports from those supplying countries [92–97]. Therefore, forest companies operating in China should find a way to operate more sustainably domestically and also make further efforts to ensure responsible business conduct if outsourcing wood.

Changing production focus includes a shift to the substitution of wood with non-wood fibers. Non-wood fiber resources, such as bamboo and straw, play an increasingly important role in solving the raw material shortage problem for China's pulp and paper industry. As a raw material used in the pulp and paper industry, recycled fiber has also become increasingly important in the global shift toward sustainability in recent years [98]. Resource-efficient use of recycled fiber has both environmental and economic advantages: it will not only reduce effluent discharges, water and energy consumptions [99], but also convert waste to useful, even novel products along with the principle of a circular economy [100]. Cossalter and Barr [80] point out that with the coastal location, the forest sector in Guangxi Province (one of the locations where our study was conducted) can benefit from this opportunity.

Last but not the least, our interviewees' skeptical attitude toward potential business opportunities from China's carbon ETS is in line with the attitude of plantation company managers interviewed in China by an earlier study of D'Amato et al. [37]. Although the forest sector is included in China's carbon ETS, the forest carbon trade market in China is still in its early stage, and it needs to be further developed and expanded [101].

6. Conclusions

Using a qualitative research approach, this study has explored the views of expert stakeholders regarding forest company dependencies and impacts on ecosystem services, as well as associated business risks and response strategies in the context of an emerging economy like China.

Because of its explorative nature, the empirical results from this qualitative study cannot be generalized beyond the dataset in a quantitative manner. That is to say, the spectrum of stakeholders' perceptions found in this study is relevant, but the frequencies of these perceptions in the population is something that only a quantitative study can provide. Nonetheless, the present study can be considered as a preliminary step to fill the pressing research void concerning the interactions between the forest industry and ecosystem services [37], and it confirms the relevance of ecosystem services thinking within corporate sustainability agendas, which is emerging in grey and scientific literature [13–15,102]. Similar investigation of other company stakeholder groups (e.g., employees and suppliers) could provide complementary information about forest company dependencies and impacts on ecosystem services [36].

Future research should focus on a broader comparative analysis of companies' internal versus external stakeholder perceptions on this topic in addition to a few existing studies from China or Australia [37,40]. In addition, more quantitative-oriented ecological research is needed to further investigate dependencies and impacts at the company or sector level. This information can also feed

into future development of voluntary corporate sustainability reporting guidelines, which would benefit from further reporting on ecosystem services information, including positive and negative communications, as well as direct and indirect impacts [20].

Furthermore, future research opportunities may also include the analysis and comparison of sustainability issues, in the form of dependencies and impacts, associated with different business models within the forest sector and across different economic sectors. Particular emphasis should be placed in further defining the idea of business dependency both conceptually and empirically [36]. This currently overlooked concept is a key to highlighting the relevance of natural systems and their services for businesses and society [40]. In our study, expert views have provided some insights for forest companies' future strategies towards sustainability, but the fundamental question on how business can truly take ecological limits and stakeholder preferences into account remains open. In this regard, the role of the forest sector can offer important insights.

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