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Selected papers from the World Sustainability Forum conference series.

Lena Berger and Manfred Max Bergman (Eds.)

Universität Basel

sustainability

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Editorial: Three Business Approaches to Responsibility and Sustainability

In the globalized world of the 21st Century, expectations associated with corporate responsibility and its derivatives, corporate responsiveness, corporate performance, corporate governance, corporate citizenship, and corporate sustainability, pose some of the major challenges but also offer some of the greatest opportunities for corporations. From different perspectives, these concepts tend to include respecting the rights and interests of stakeholders, acting ethically, adopting and enforcing codes of conduct, and contributing to sustainable development, among others. Each take on corporate responsibility is characterized by differing contents and goals, thus suggesting a different route toward, and variant of, sustainability. However, most can be classified into three categories: traditional corporate responsibility, regulations and standards-based responsibilities, and responsibilities as business opportunities.

The traditional corporate responsibility approach is grounded in the field of business ethics and focuses on moral values and principles as part of the so-called DNA of corporations. According to this approach, intensive and exclusive pursuits of economic goals, especially shareholder value or profits, tend to foster corporate behaviors that may violate basic rights and universal ethical principles, thus threatening to undermine a morally sound position. To become responsible agents, corporations are encouraged to internalize sets of moral values and principles such as fairness, justice, mutual benefit, caring, transparency, impartiality, honesty, and integrity. According to many authors in this field, these principles ought to be prioritized over any economic goal in the long-term interest of corporations. Responsible corporations, so the argument goes, act in accordance with moral principles even in cases where the resulting action is associated with negative economic outcomes. Although contentious, others argue that moral corporate behavior leads to increased profits in the long run ("Doing well by doing good"). From this perspective, acting ethically is at best profitable and more generally a desirable end in itself.

Corporate responsibility from a regulations and standards perspective assesses corporate behaviors against a set of fixed criteria or predefined goals, such as diversity, transparency of executive compensation, charitable donations, greenhouse gas emissions, use of pesticides, investment in clean energy, and commitment to fair pricing and compensation. This approach conceptualizes responsibility as a construct that is an operationalizable, measurable, quantifiable, and comparable entity in that the application and integration of specific criteria determines the overall degree of responsibility or sustainable behavior of a corporation. Accordingly, corporate behavior can be audited and its performance

certified. Motivations for adopting standards include the ability to systematically monitor and manage risks inherent in the non-economic sphere of doing business and the intent to gain a competitive advantage by enhancing the brand's value or reputation through favorable assessments beyond monetary criteria.

Traditional corporate responsibility and regulations and standards approaches to responsibility have in common that they separate responsibility and sustainability from core business. Corporate responsibility in this sense is understood as a secondary responsibility, an "ought to" or "should", an elective by enlightened leadership or management, or a strategy and marketing tool. The major drawback of this bifurcation between the pursuit of economic responsibilities as the core of business activities and most other responsibilities as electives is that such a representation of responsibilities is disconnected from business operations and the business context. Manifestations of this dyadic position are the separation of corporate responsibility units from other business units, the separate publication of financial and corporate responsibility reports, the understanding of corporate responsibility as a peripheral exercise, social engagements measured in dollars rather than quality of outcomes, minimalistic social and environmental engagements, etc. This is not to say that initiatives motivated by traditional corporate responsibility or by regulations and standards do not have an impact. Rather, their impact often falls short of its potential.

The third approach to corporate responsibility, i.e. responsibility as a business opportunity, offers an alternative understanding of the relationship between core business and its responsibilities. Engaging with social and environmental issues within the business model may be regarded as a business opportunity and, accordingly, economic, social, and environmental spheres can be understood as highly integrated and inseparable. Two types of opportunities can be distinguished: opportunities related to philanthropic engagement and opportunities related to products and services. Corporate philanthropy is voluntary and typically intends to benefit a sector of society or the environment. However, whether intended or not, philanthropy often feeds back to the business interests of the corporation. For example, as part of its philanthropic engagement, the Swiss branch of the Zurich Insurance Group provides approximately 500 "vitaparcours", free and public sports and health trails to build strength, conditioning, agility, and coordination. Beyond a gain in brand recognition and positive image, Zurich Insurance Group contributes to health and accident prevention, which in turn is beneficial to its core business. Lee Kum Kee's "Hope as Chef" initiative follows a similar pattern: The producer of Asian sauces sponsors young people from underprivileged areas in China to learn Chinese cooking skills, thus giving them the opportunity to participate in professional vocational training, while simultaneously promoting Chinese cuisine, its core business.

Opportunities related to products and services focus on gaining a competitive advantage by optimizing and future-proofing production and services via shared value creation, and by taking into account and co-defining a changing social, environmental, and business climate. For example, the company Vestergaard offers portable water-cleaning solutions for drinking water. The car company Tesla occupies a unique market position by providing electric luxury cars, which combine the fight against air pollution with the prestige of exclusive sports cars. Vodafone successfully introduced a low-cost, phone-based banking service, M-Pesa, in developing markets. These examples illustrate the many ways forward-thinking corporations understand corporate responsibility and sustainability as business opportunities. They regard social and environmental issues as a central part of their business.

In sum, there are many different ways to formulate and enact corporate responsibility and sustainability. Many initiatives contribute to the overarching goal of sustainability and a mutually beneficial relationship between business and society. In this special issue, we explore different approaches to corporate responsibility, sustainability, and reporting. The considerable scope displayed in the contributions of this special issue illustrate how widely applicable corporate responsibility and sustainability are, and how the private sector is called upon to partake in social development and environmental management – for the long-term prosperity of business and society.

Lena Berger and Manfred Max Bergman
Editors

Corporate Sustainability, Global Values and Pluralistic Societies: What Can We Know? What Ought We to Do? What May We Hope?

Klaus M. Leisinger

> The future cannot be a continuation of the past, and there are signs . . . that we have reached a point of historic crisis. The forces generated by the techno-scientific economy are now great enough to destroy the environment, that is to say, the material foundations of human life. The structures of human societies themselves, including even some of the social foundations of the capitalist economy, are on the point of being destroyed by the erosion of what we have inherited from the human past. We do not know where we are going. We only know that history has brought us to this point. However, one thing is plain. If humanity is to have a recognizable future, it cannot be by prolonging the past or the present. If we try to build the third millennium on that basis, we shall fail. And the price of failure, that is to say, the alternative to a changed society, is darkness.
>
> Eric Hobsbawn [1] (p. 584 f.)

1. Introduction

Eventually, the time will come when "sustainable development" is assigned the place it deserves in the international political discourse and practical transformation endeavors. After the Rio +20 Conference on Sustainable Development in 2012, thousands of experts, tens of thousands of government employees and civil society activists, and millions of people all over the world are dedicating their energy to the initiation of reform processes to help realize the *Future We Want for All* [2]. In the coming months, the international community will deepen the understanding of sustainability and create a consensus on a plan of action necessary to implement the 17 Sustainable Development Goals (SDGs) and the 169 associated targets [3].

The goal of the sustainable development endeavors—very similar to the aspiration articulated in the Preamble of the Universal Declaration of Human Rights—is a new common standard of practices for all peoples and all nations, to the end that every individual and every organ of society, keeping the necessity for a sustainable development path constantly in mind, shall strive to promote coherent action and implement state-of-the-art national and international measures

progressively to secure universal and effective recognition and observance. The primary responsibility for sustainable development lies with every one of us—no governmental regulation can substitute individual environmental and social awareness and respective conduct. Small changes among the 1.5 billion people at the top of the global income pyramid with regard to, e.g., the use of energy, water, non-renewable raw material, or mobility patterns, will make a bigger difference to global sustainability than a UN resolution or government regulation would ever be able to.

Yet, national governments and their administrations can facilitate and accelerate behavioral changes by mobilizing domestic resources, e.g., for sustainable infrastructure and renewable energy, set the appropriate purchasing priorities and allocate the resources available to them coherently. The extent to which this plan of action for people, planet and prosperity will be implemented also depends on the willingness of the developed countries to fulfill their official development assistance commitments, in order to enable the transfer of technology and help finance appropriate infrastructural investments.

More than ever before, the success of sustainability endeavors depends on multi-stakeholder partnerships that "mobilize and share knowledge, expertise, technology and financial resources, to support the achievement of the sustainable development goals in all countries, in particular developing countries" [3] (Point 17.16). It is in the context of such multi-stakeholder partnerships that the corporate sector—the single most efficient source of economic activity and innovation—is expected to support the collective global reform journey. Large international corporations can and should play a leadership role in this respect. The goals are ambitious; the international community is committed to

- end poverty and hunger;
- secure education, health, and basic services for all;
- achieve gender equality and empower all women and girls;
- combat inequalities within and between countries;
- foster inclusive economic growth, shared prosperity, and sustainable lifestyles for all;
- promote safe and inclusive cities and human settlements;
- protect the planet, fight climate change, use natural resources sustainably, and safeguard our oceans;
- strengthen governance and promote peaceful, safe, just and inclusive societies; and
- revitalize the Global Partnership for Sustainable Development.

There is no blueprint, no straightforward solution valid for all countries under all circumstances to achieve economic prosperity, social inclusion and cohesion, and

environmental sustainability. From a sustainability perspective, all countries are "developing" countries, albeit in different ways. There are substantial similarities with regard to aspects of poverty and the need for interventions in poor countries. There are also structural resemblances with regard to the resource-intensive production, consumption, and mobility patterns of rich societies. In addition, there is an overarching need for improved governance. However, despite all of this, the content and timing of action plans for sustainable development remain context-specific and a consequence of the complex interaction of local economic, social, political, ecological, and cultural factors.

Sustainable development is a normative concept in as much as there are a number of dilemmas that have to be addressed by deciding which of the economic, social, ecological, human rights–specific, and cultural values at stake should take precedence in a concrete situation. Priorities assigned in such decision processes depend on values, worldviews, and the variety of diverging interests of the different stakeholders involved. To construct a tailor-made reform process that satisfies all relevant stakeholders is already difficult for a modern pluralistic society such as Switzerland, Germany, or the United States—it becomes far more complex if we take into consideration countries such as China, India, Brazil, or sub-Saharan countries with their differing stages of socio-economic development. Context-specificity and normativity apply also to companies: the scope, content, structure, and speed of corporate sustainability processes depend on the size, sector, geographical location, profitability, political, and cultural operating context.

From all we know today, the implications of a continued unsustainable development path will be more poverty, widening inequalities, less food security, more sickness and premature death, more weather extremes, and eventually also more civil strife and war due to an increasing scarcity of vital resources [4]. This makes the implementation of the Sustainable Development Agenda, i.e., achieving the SDGs, not only a national and international technical, economic, or political issue but also a moral obligation for everyone capable of making a contribution. I will therefore approach my suggestions in a way recommended by Immanuel Kant in his *Critique of Pure Reason* [5] (p. 671ff.), namely with the following three questions:

1. What can we know?
2. What ought we to do?
3. What can we hope for?

2. What Can We Know?

Most of the knowledge about the root causes of our currently unsustainable development path and the reform processes necessary to steer spaceship Earth into a *future we want for all* is easily accessible [4]. There are some issues on which scientists

continue to disagree. As a way of dealing with the lack of full scientific certainty, however, the international community accepted the precautionary principle [6] at the Rio Conference on Environment and Development in 1992.

We also know that the context-specificity, the inter-generational aspects, and the normativity of sustainable development issues make the lives of political and corporate decision-makers difficult: they all face significant incentive problems as they must make decisions that result for themselves and others in

- paying for investments or higher user fees today which have only a very long-term return for anonymous people and occur mostly far away from home;
- accepting concrete inconvenient changes in accustomed production and consumption habits today for a minuscule long-term benefit elsewhere and in the future;
- putting up with potentially uncomfortable restricted patterns of individual mobility today for an infinitely small contribution to the prevention of problems in the future; and,
- especially for politicians, inflicting short-term burdens today on electoral constituencies by which they want to be re-elected for long-term change and benefits far beyond the election cycles.

The burden of costs and inconveniences is incurred immediately while their possible returns only emerge in the longer run—and probably for different people at different places in the world. This does not fit into the usual pattern of individual, political, and corporate decision-making. All of this makes achieving sustainability a "wicked problem" [7]—"wicked" not in the sense of being evil, but because the problems are tricky, devious, messy, ambiguous, interacting and evolving in a dynamic societal context. Part of the wickedness is caused by the fact that a huge number of people were involved in the genesis of the problem and need to be included in the solution attempts. To "tame" [7] a problem of the complexity, dimension, and wickedness presented by the overcoming of the current unsustainable development path, multiple stakeholders all over the world need to be involved: civil society organizations representing the people affected, governments, multi-lateral institutions, academia, and the private sector.

Obviously sustainable development depends not only on enlightened corporate leaders doing the right thing, but also on a good governance framework that strives for the internalization of external costs. The power of market forces can only be used for sustainability if the prices express the ecological and social truth. It also depends on consumers to align their purchasing power with the available knowledge. To accelerate this process, sustainability education and training is necessary starting at primary school and progressing all the way through to university studies in order to shape public awareness about the sustainability requirements.

Having said this, we shall concentrate on the role of corporate leadership. Corporate decision-makers can know that legality is only the non-negotiable ethical minimum as, in many countries, local legislation fails to keep up with the progress of knowledge about sustainability, and enlightened managers are not content with observing merely the ethical minimum. Living up to the necessities of sustainable development—let alone assuming a leadership role in this reform process—involves much more than a legalistic "compliance definition" of corporate sustainability responsibility. Leaders will therefore strive for legitimacy in their conduct. This means, first and foremost, integrating sustainability into all organizational processes and using available knowledge and capabilities to continuously align strategies, policies, practices, and technologies of all those involved. This will facilitate coordination and collaboration, create synergies in "doing things right", and simplify innovation.

Enlightened corporate leaders are aware of the necessity, the usefulness, and the power of stakeholder dialogues and partnerships. They are necessary, because different knowledge, skills, experiences, and resources become available; useful, because they offer an opportunity to advocate and defend one's own legitimate corporate interests; and powerful because unorthodox coalitions can trigger new business models. Unorthodox dialogue partners questioning customary "self-evidentialities" and predominant ideologies (e.g., the dominance of the shareholder value principle) create an atmosphere in which new thinking can develop. Enlightened corporate leaders know that a business as usual approach to managing corporate affairs is not sufficient to initiate and support the necessary global change, of course, nor is looking at corporate sustainable development exclusively through the lens of short-term "profitability vs. non-profitability". The consequences from accumulated knowledge about sustainability must be new practices.

3. What Ought We to Do?

3.1. Acting with Integrity and in the Spirit of the "Golden Rule"

The first idea that strikes sensible bearers of responsibility in the business world in connection with the question "What ought we to do?" is: Acting in a way which is in line with the available knowledge and in accordance with one's personal value convictions—in other words: Acting with integrity. A second thought that comes to morally sensitive business leaders is: "Live up to the spirit of the Golden Rule" [8] in an intergenerational manner.

3.2. Reflections of Top Management

To comprehend what integrity and the Golden Rule mean in concrete practical terms, a fundamental reflection on sustainability values is necessary. Likewise, a deep understanding of the shared aspirations of the Sustainable Development Agenda and the background of the goals set by the international community must be part of this process. This non-delegable obligation of the top management is "half of the whole" [9]. With the achievement of a full understanding of the problem, an essential part of the solution has already been found [10] (p. 155).

Most of the companies I know went through such a reflection process when they produced their mission statement and values catalogues in the 1970s and 1980s, as was the fashion then. If no strategy revision, merger, or diversification acquisition followed, the mission statement usually landed in the "done" file or in the company archives. This is not how it should be: changed economic relationships resulting from globalization, different social expectations, and increased sensitivity of people to ecological and social issues in modern societies should have made a periodic examination of the mission statement and the values catalogue a matter of course. Leaving the mission and values statements in the "done" file is totally inappropriate in the face of the challenges brought by the Sustainable Development Agenda. Among the questions an enlightened top management must answer in this regard at regular intervals are the following:

- What values do we stand for and what does that mean in the context of sustainability?
- What should the world look like that we wish to hand on to our descendants?
- What could be our corporate contribution to that kind of world?

What rules in this respect govern priority-setting in the case of dilemmas, e.g., between the size of short-term profits and the consideration of long-term ecological interests or social inclusion?

Such an internal reflection of top management leads to better insights if all relevant stakeholders have been involved. Understanding their issues and expectations, knowing their concerns and interests broadens and deepens the decision basis. Without a principled debate on such issues at the top level of management, the corporate cultural compass cannot be aligned or employees committed. In such cases, the burden of decision responsibility is shifted down to employees at a lower level of the hierarchy working under the pressure of time and resources. This is not the right place as such decisions are most often not a free lunch affair, e.g., when

- the cheapest suppliers are not taken into account because of degrading working conditions or destructive environmental practices; or when

- locations in distant countries to which production has been shifted have conditions that are incompatible with a sober sustainability perspective, and consequences that cost money have to be drawn to deal with the deficiencies.

Given all the potential for future business opportunities and first adaptor cost advantages, reforms for sustainability can have negative effects on turnover, costs, and ultimately on profits. Such negative effects cannot be compensated for in the short term—if at all—by gains in reputation and the higher motivation of employees and customers. They are the price to be paid for integrity, and as such, an investment in corporate sustainability and credibility.

3.3. Values Management

A coherent practical follow-up on these basic reflections is the initiation of a congruous, anticipatory, strategic sustainability values management process through which respective organizational governance is adapted and management systems extended. This primarily involves the inclusion of sustainability values and rules in the leadership principles of the organization, so that criteria such as ecological sustainability, social inclusion, as well as human rights aspects [11] are placed alongside the variables of economic success in the decision matrix of the enterprise. Further decisive elements of sustainability values management are codes of conduct and corporate sustainability guidelines as well as sustainability-sensitive criteria in regard to target-setting and performance appraisals to make all bearers of responsibility accountable and to provide incentives for proper conduct. Sincere sustainability thinking impacts the entire corporate value chain, beginning with the sourcing of raw materials, transportation services, employment practices, environmental stewardship in the production processes, packaging, delivering, also impacting the use of products and services by customers all the way through to the final product disposal, reuse, or recycling.

All new investments will undergo a sustainability-due diligence assessment and—where applicable—research and development objectives will be complemented with sustainability issues. In this way, out of the endless number of theoretically possible forms of action, those will be filtered out, prescribed, and encouraged that can be considered legitimate and desirable from a sustainability perspective. There is (hopefully!) increasing evidence that sustainability values management does not have to depend on enlightened leaders' good will only, but has a positive impact on future business opportunities, reduction of risks, and improvement of societal acceptance (license to operate) [12]. Once the "compass" is set, practical implementation begins [12]:

- Detecting and analyzing the areas in the business operations and supply chain where the likelihood of an either negative or positive impact on sustainable

development goals is highest. A number of tools for mapping hotspots in the business operations and the value chain are already available [13].

- Defining performance indicators against which progress can be measured in mitigating negative or strengthening positive impacts on the 17 SGDs.
- As not everything necessary or desirable can be done at the same time, priorities will have to be defined according to the significance of the impact.
- The setting of SMART (specific, measurable, achievable, realistic, and time-bound) targets aligned with the SDGs helps to manage performance and—if proper baselines are available—creates transparency about the level of ambition [14].
- Communicating results of corporate endeavors is a last and equally important step. If not only successes and progress are reported but also problems not solved, set-backs suffered, and obstacles faced, communication will not only enhance the credibility of the work done but also show the complexity of the whole process. Whenever dilemmas cannot be avoided, they ought to be dealt with openly and transparently. The Global Reporting Initiative (GRI) principles for sustainability reporting provide a helpful framework [15].

3.4. Complex Problems do Not Have Simple Solutions

There are forms of unsustainable business conduct that permit no compromise. This is the case when, in the interest of increasing profits or for any other economic reasons, human life is threatened, human rights and dignity violated, human health endangered, or if the integrity of creation is irreparably damaged. Such actions are irresponsible, indeed evil and therefore there exist no areas for compromises or tolerance.

In practice, however, the question seldom arises as to what should be done in the best of all worlds or unconditionally avoided under the worst possible circumstances. Normally, human reality does not happen in "black or white", but in "grey" areas. There, as Max Weber pointed out in his 1918 lecture on *Politics as a Vocation*, most decisions have dilemma character, and

> No ethics in the world can dodge the fact that in numerous instances the attainment of 'good' ends is bound to the fact that one must be willing to pay the price of using morally dubious means or at least dangerous ones—and facing the possibility or even the probability of evil ramifications. From no ethics in the world can it be concluded when and to what extent the ethically good purpose 'justifies' the ethically dangerous means and ramifications. [16] (p. 29)

To adequately judge business activities from a sustainable development perspective, a situation-ethics approach is often the right procedure. In such an

approach, respectful use is made of all the sustainability principles in order to evaluate which norms should be given which weight in the given situation. It is no longer a question of isolated analysis based on a single preferred economic, social, ecological or governance norm. Situation ethics represents an all things considered assessment, which weighs up all arguments before a decision is taken [17]. In such decision situations, often compromises have to be reached—i.e., a desirable economic aspect might be "sacrificed" for an ecological or social aspect that in the given situation is considered to be more important. If we look at the sustainability agenda from a moral perspective, this means that a moral compromise has to be reached [18]. An all things considered decision could temporarily be the best possible or the least bad option. Using situation ethics is admittedly a dangerous tightrope act. If the search for shared values and a moral common sense is part and parcel of decision-making processes involving such compromises, moral dangers can be mitigated. Let us now turn to the last question from Immanuel Kant's canon:

4. What Can We Hope for?

> Our problems are manmade, therefore, they can be solved by man. And man can be as big as he wants. No problem of human destiny is beyond human beings. Man's reason and spirit have often solved the seemingly unsolvable—and we believe they can do it again. [19]

This message that John F. Kennedy gave more than 50 years ago has never been more relevant. Whatever has to be done to change course and bring humanity back on a sustainable path of development—it has to be done by human beings. There are two main areas of hope in this respect; first, human beings all over the world integrate sustainability in the way they define a "good life" and "happiness", and, second, human ingenuity brings about technological progress which helps to stretch the timespan needed for eventually adopting voluntarily sustainable consumption, production, and waste patterns.

4.1. The Sustainability Man (Homo Sustinens)

Evolutionary predecessors of modern humans, e.g., *Homo habilis*, *Homo erectus*, or *Homo sapiens*, were able to survive and develop because they were innovative and able to adapt to changing circumstances. The shared understanding of the majority of scientists, representatives of civil society, as well as a growing number of enlightened leaders from the corporate sector suggests that modern human beings—9.7 billion by the year 2050 [20]—will also have to adapt their lifestyles if a substantial negative impact on the life and options of future generations is to be avoided. Humankind can do this.

In his *Oration on the Dignity of Man* of 1486 [21], Giovanni Pico della Mirandola described his idea of man in a beautiful, poetic way. He characterized man as "the most wonderful creation of the world", "the intermediary between creatures, familiar of the gods above him, the lord of the beings beneath him, by the acuteness of his senses, the inquiry of his reason, and the light of his intelligence, he is the interpreter of nature, set midway between the timeless unchanging and the flux of time; the living union, the very marriage hymn of the world, little lower than the angels." [21] (p. 4) Further, Pico lets God tell man something important for all spheres of human decision-making, i.e.,

> ... with free choice and dignity, you may fashion yourself into whatever form you choose. To you is granted the power of degrading yourself into the lower forms of life, the beasts, and to you is granted the power, contained in your intellect and judgment, to be reborn into the higher forms, the divine. [21] (p. 7f)

Individual responsibility for sustainability cannot be shifted onto others and not doing "the right thing" despite knowing the consequences of not doing it cannot be attributed to a lack of good governance, wrong financial incentives, or obstructive market circumstances. The hope is that human beings all over the world in all their professional and private roles accept responsibility for sustainable development and act coherently in their sphere of influence in a spirit of shared values and shared responsibility. The hope is that the comprehension of what is at stake should bring about the willingness of all actors all over the world to act coherently and to contribute in good faith to the endeavors of others.

Business has a pivotal role to play; significant progress will result only when companies go further than business as usual and integrate the Sustainable Development Goals into business strategies, research and development, as well as into the development of innovative products and services. In the spirit of what Pat Werhane [22,23] advocates with regard to "moral imagination", corporate management must become aware that every business decision and action has a sustainability dimension—for practically all business decisions, there are alternative options, options which are of greater value from a sustainability point of view. The mobilization of imaginative powers and the extension of the mental horizon sharpen the awareness for the use of existing room for maneuvering toward the *Future We Want for All* [2]. Integrity—commonly defined as acting consistently with one's knowledge and values—demands the implementation of corporate reform processes consistent with the ecological, social and (not merely) economic knowledge available. There is a robust consensus on globally shared values representing the common tie that binds humanity [24].

4.2. Technological Innovations for Sustainability

Never before have science and technology progressed so fast. If one looks at the science-based technological advances achieved, e.g., in the areas of information and communication technologies, genomics, chemical engineering, nanotechnology, or biology, one realizes that what seems perfectly normal in 2015 is incomparably more than what even optimists considered possible just a few years ago. With resources being priced properly and attractive incentives for research (intellectual property) provided, a new generation of products and services with totally new sustainability features will become reality. Resource-intensive and ecologically damaging goods will become more expensive and hence less attractive for use. The higher prices will encourage the search for substitution through innovation. If markets are made to work for the environment by applying full-cost pricing along with the polluter-pays principle, ecological innovation will be encouraged on the product and process level.

When *The Limits to Growth* [25] was published in 1972, it received enormous attention—and stirred enormous fears. Today we know that the projections presented by Dennis Meadows and his colleagues underestimated the potential of economic feedback mechanisms and human creativity leading to improved technologies and substitution mechanisms. Yes, there are new problems humankind is currently not able to cope with, be it the acceleration in the accumulation of greenhouse gases or the reduction of biodiversity, but overall, things have developed in a positive direction: Despite a more than doubling of the world population over the past 50 years and a substantial increase in consumption, most metals, foodstuffs, and other natural resources have become more available rather than scarcer over time. As most of the world's known reserves [26] went up, the prices (adjusted for inflation) of most natural resources came down. The main pollutants have lessened in most industrial countries, and air and water quality have improved. Micro-organic diseases such as smallpox, plague, cholera, typhus and the like, which threatened the lives and health of earlier generations in industrial countries, have been successfully conquered and are much better contained than they were 50 years ago. There is also spectacular progress in the management of diseases such as human immunodeficiency virus (HIV) and malaria; smallpox has been fully and polio nearly eradicated.

Will the future be so different? The answer to this question depends, according to the late Julian Simon, on the response to another question: Will the rate of technological development slow down [27,28]? He would argue today as he did 20 years ago: the pace of development of new technology is increasing. Hence, if the future differs from the past, the bias is likely to be in the direction of underestimating the rate at which technology will develop. The value and weight of "the ultimate resource" [27] as Simon called human ingenuity, supported by the proper economic signals in a free society, are today still not properly taken into account when discussing sustainable development issues. Better technologies

available today have already changed the definition of eco-efficiency, and more of the same is to be expected [29].

Human ingenuity is the single most powerful force for sustainable development. Specific resources (e.g., copper) are no longer or significantly less needed for the particular services they can yield (such as the capacity to conduct electricity), since there are substitutes (such as optical fibers) [27] (pp. 23–73). Amory Lovins made the same point long ago in arguing for the potential of energy efficiency [30,31]. If scientists are able to assemble atoms and molecules into new materials that can be substituted for a scarce resource, that specific scarcity becomes irrelevant. There is no reason to assume that similar mechanisms will not help to deal better with emission issues—it is something one can dare to hope. Yet, taking the precautionary principle seriously suggests not relying entirely on technological solutions—a change in consumption, production, and waste patterns is unavoidable in the long-term.

Willy Brandt addressed an important message to his friends in the last days of his life:

> Nothing happens of its own accord. And very little is lasting. Therefore be aware of your strengths and of the fact that each era requires its own answers and that you really must feel up with its expectations if you hope to achieve good things. [32]

We know what is at stake; it is obvious what we ought to do—we may hope that we will succeed.

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Corporate Responsibility Expectations in China: Advanced Business and Economics Students from Beijing

Lena Berger, Zinette Bergman, Jiaqi Zhang, Baocheng Liu, Klaus M. Leisinger and Manfred Max Bergman

Abstract: In this study, we examine the influence of culture and context on corporate responsibility expectations of future political and economic leaders in China. In contrast to implicit assumptions in the established literature, corporate responsibility is not universally shared and understood independently of context and culture. We explored corporate responsibility expectations of 80 advanced business and economics students from first-tier universities in Beijing. The data for this study consisted of essays written by the participants. Hermeneutic Content Analysis was used on the essays, which includes a combination of Content Configuration Analysis and Multidimensional Scaling. Our results revealed that, according to our respondents, corporations ought to be fully integrated into a meta-system that includes the state and society. Corporate success in terms of technological advancement, profits, and market share are thought possible through collective contributions by the state and society, which in turn expect considerable, systemic, and continuous contributions by corporations toward national socioeconomic development and prosperity. The responses seemed entirely independent of the business and economics literature to which the respondents are exposed. Furthermore, the respondents understood the interdependent and reciprocal relations within this meta-system with reference to the Chinese nation. Profit seeking or market share increase in their own right, or references to corporate responsibilities beyond national boundaries were mostly absent.

Keywords: corporate responsibility; culture; China; Hermeneutic Content Analysis; Content Configuration Analysis; collectivism

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One heart, one soul,
One mind, one goal

Extract from the national anthem of
the People's Republic of China.

1. Introduction

Studies on culture in the business and management literature have traditionally focused on statistical differences of survey responses on leadership, management, and work environments between nations or industry sectors. Corporate responsibility (CR) and expectations thereof have rarely been the focus of investigations from a culture-sensitive perspective, primarily due to the assumption that most conceptualizations of CR are based on seemingly universal notions of business ethics [1,2]. However, corporations are deeply embedded in the culture of communities and societies within which they operate, and the needs and expectations of these communities and societies are vital for the understanding of CR expectations. A context-sensitive and culture-relevant understanding of the relationship between business and society in different nations and cultures would sensitize our understanding of stakeholder positions when interacting and negotiating within and between cultures. This has been particularly important since the turn of the century, when massive geopolitical and economic power shifts have led to a renegotiation of business practices in a global market place in general, and with regard to developing economies' accelerating developmental trajectory and global ambitions in particular. In this sense, China is particularly relevant, considering its trajectory and global development initiatives, for example the Silk Road Economic Belt or the Maritime Silk Road initiatives.

In this study, we investigated the CR expectations of business and economics students from first-tier universities in Beijing for the purposes of understanding the contextual and cultural dimensions of what is expected from corporations. The perspectives of the research participants are particularly significant because they are the beneficiaries of China's rapid development and because they are faced with some of the negative consequences of socioeconomic change. As advanced business and economics students of elite academic institutions, they represent a population of future political and business leaders and decision makers. As such, their perspectives provide insights not only into current expectations but also the influence they may have on future business-society relations in China. In this article, we are pursuing two aims: to systematize the influence of context and culture on CR expectations of business and economics students from Beijing, and to illustrate how such a context-sensitive and culture-relevant approach to CR can be of value to the understanding of business-society relations in China.

2. Theoretical Background

Cross-cultural studies have primarily focused on contrasting and systematizing cultural patterns between nations or how managers or employees relate to others [3–6]. In its most simplified form, cultural differences can be explained as the extent to which cooperation and competition, for example, are emphasized [7]. Culture shapes

and is shaped by shared beliefs, attitudes, norms, values, and behaviors, resulting in systemic variations in economic, political, social, and cultural systems [5].

Culture and globalization: While cultural studies have identified a multitude of different cultural dimensions and their relations to social and economic structures, one of the most decisive and mutually agreed value dimension pertains to individualism vs. collectivism. In collectivistic societies such as China, the interests of the collective is given priority over the interests of the individual. In contrast, in individualistic societies, the reference entity tends to be the individual. Somewhat simplistically stated, in the latter, wellbeing is dependent on the protection and expression of individual rights, while, in the former, the collective's wellbeing is the main objective of all of its members. Due to individualization, globalization, and Westernization, some argue that cultural dimensions, such as cooperation vs. competition or individualism vs. collectivism, no longer describe modern societies adequately [8]. Tomlinson [9] (p. 269) argues that "before the era of globalization, there existed local, autonomous, distinct and well-defined, robust and culturally sustaining connections between geographical place and cultural experience." Ostensibly, this is no longer the case because we live in a highly interconnected and interdependent world, characterized by the daily, worldwide exchange of capital, goods, services, and information [10]. This has led some theorists to argue that cultural identity has lost its local roots as it became a product of globalization [9,11]. Accordingly,

> cultural experience is in various ways 'lifted out' of its traditional 'anchoring' in particular localities [leading to] a transformation in our routine pattern of cultural existence which brings globalized influences, forces, experiences and outlooks into the core of our locally situated lifeworld. [9] (p. 273)

Based on this, theories on the globalization of culture tend to conclude that globalization homogenizes or fractures culture.

An alternative variant of this view is that cultural variations disappear due to cultural imperialism. According to Kellner [12] (p. 23), Western cultural imperialism has emerged through "strengthening the dominance of a world capitalist economic system, supplanting the primacy of the nation state by transnational corporations and organizations, and eroding local cultures and traditions through a global culture." Economic globalization from this point of view has its origins in Western capitalism that nurtures Western and individualistic values [10]. Globalization ostensibly fosters standardization whereby exposure to global markets and mass media enhance acculturation and homogenization of value systems, lifestyles, and consumption. Zang and Shavitt [13] identified the influence of Western mass media, especially via advertising, on shaping Chinese cultural values. According to them, Chinese Generation X

> is partly the product of Chinese modernization and global marketing. These young adults live in the cities in which there are growing numbers of international contacts, networks, and organizations (Hermans and Kempen 1998). Geographically, most of these cities are located along the east coast of China, such as Beijing, Shanghai, Guangzhou, Dalian, Qingdao, Nanjing, Wuhan, Xiamen, and Shenzhen. . . . [The] geographic, economic, and educational characteristics of the Chinese X-Generation put them in a position to be more influenced by Chinese modernization and provide more opportunities for exposure to other cultures. In addition, an extensive exposure to mass media and advertising accounts for the Chinese X-Generation's cultural adaption. . . . In general, these young urban adults were found to be more receptive to advertising communication and to welcome Western values and ideals . . . As such, these young urban adults represent the context in which cultural change is likely to be the most rapid and have the greatest long-term impact. In other words, the Chinese X-Generation exists not only as a profitable market, but also as a force that determines the cultural orientation of China's future (China; X-Gen Study 1996). (pp. 23–24)

In line with globalization theories, which tend to focus on the hegemonic influence of individualistic, Western consumer lifestyles on local cultures, their results suggest that Western-style advertisements encourage an adoption of Western value sets, especially among Generation X.

In contrast to cultural homogenization, other scholars emphasize the fracturing nature of globalization. Instead of a Western-based monoculture, they propose that globalization is appropriated differently by different groups and cultures, thereby increasing the opportunity for new forms of hybrid syntheses, variety, and diversity [12]. According to Xue [11] (p. 112), "American food, music and films are available all over China. These American commodities are becoming Chinese favorites and consumption of American commodities has been an authentic and everyday practice. Thus, the term cultural imperialism is out of date and is problematic because it can't explain what is happening in this society and interpret the cultural meaning at a micro level."

Accordingly, Western cultural influences are only partially appropriated. They are interpreted in new, hybrid forms, and embellished in a novel, yet thoroughly Chinese interpretation.

Context: While culture is indeed an important behavioral predisposition, the immediate context, including socioeconomic, political, or relevant person-specific events, for example, may subdue, qualify, neutralize or even aggravate the effects of culture. There exist many contextual factors that may influence CR expectations of advanced business and economics students in China. Here, we will briefly cover two:

the influence of China's current political landscape, especially the institutionalization of corporations by the Communist Party (CP), and the influence of exposure to the mostly Western, mainstream CR literature.

Especially since the late 1970s under Deng Xiaoping, the CP has transformed Chinese society through massive economic reforms, increasing the quality of life for Chinese people in unprecedented ways. The Chinese leadership under the Hu-Wen administration has made several policy adjustments in 2005 to further reform the economy, for example, by building the Harmonious Society as one of the primary long-term goals [14]. To ensure the collective welfare of its citizenry, the CP has implemented progressive CR legislation to help guide the actions of public and private corporations. Some of these include the *Guide on Listed Companies' Social Responsibility*, the *Guide on Environmental Information Disclosure for Listed Companies*, or the *Guide Opinion on the Social Responsibility Implementation for the State-Owned Enterprises Controlled by the Central Government*, which set out the guidelines for how state-owned enterprises should engage in CR, and Article 5 of the 2006 *Chinese Company Law*, which states that "[i]n the course of doing business, a company must comply with laws and administrative regulations, conform to social morality and business ethics, act in good faith, subject itself to the government and the public supervision, and undertake social responsibility" [14] (p. 71). The stance taken by the CP and the associated legislative policies shows that, in relation to large corporations, there are well-defined expectations fundamental to the Chinese context, which are neither accounted for by cultural dimensions nor by globalization. While some of our respondents may not be familiar with legislative policies that define the responsibilities of large corporations in modern China, they may nevertheless contribute to the contextual environment that influences how elites reflect on the responsibilities of corporations.

Parallel to these developments are educational effects on our respondents: According to Doh and Tashman [15], CR and sustainability have gained attention among business schools worldwide as these concepts were integrated into curricula in an attempt to overcome a disconnect between CR and core business practices. While CR theories have traditionally differentiated between the economic responsibilities of large corporations, such as production and value creation, and other, non-economic responsibilities, including legal, ethical, philanthropic, and social responsibilities [16–19], contemporary applications transcend this bifurcation. This is encapsulated in approaches such as the three pillar model of corporate sustainability, which connects economic, social, and environmental components to business practice (e.g., [20]). While traditional business ethics have been widespread in the business, management, and economics literature for several decades, others, such as concepts associated with sustainable development, are new to academia. Our respondents have been exposed to the mainstream literature on CR based on

the diffusion of the mostly Western or Western-influenced literature on business ethics in Chinese business and management programs. Despite exposure, however, we do not expect that academic CR concepts have influenced our respondents' expectations, given the superficiality with which business ethics are covered in competitive business and economic programs and the powerful socialization the respondents experience from continuous exposure to their powerful national culture.

Thus, while we anticipated some superficial reference to Western CR and sustainability, we nevertheless expected that our respondents would reflect on the responsibilities of large corporations in ways that harmonize with socioeconomic reforms of the recent past and contemporary global ambitions of China.

3. Methods

Eighty advanced business and economics students from first-tier universities in Beijing were invited to write a short position paper about the responsibilities of large corporations in China. Specifically, our respondents provided written responses to questions, posed in Mandarin, on responsibilities of large corporations and why corporations held such responsibilities. The thus produced essays, initially written in Mandarin, were translated into English for analysis. Data was analyzed using Hermeneutic Content Analysis (HCA) [21]. HCA is a three-step mixed methods approach, which combines Content Configuration Analysis (CCA) [22,23] and Multidimensional Scaling (MDS). CCA is a qualitative method of analysis, which can be applied to all non-numeric data, including written, visual, and audio data. As a method of analysis, CCA has been used in a variety of fields, such as business, economics, philanthropy studies, public health, education, media studies, mobility studies, and sustainability studies. MDS is a quantitative dimensional analytic technique used to visualize the relationship between objects in multidimensional geometric space based on how these objects systematically co-occur. In our research, we have used MDS to analyze the perspectives of various stakeholders in relations to ethics, business practices, organizational theory, CR, and culture.

4. Results

4.1. Results 1, HCA Step 1—CCA: Thematic Dimensionality of the Perspectives of Beijing Students on the Responsibilities of Large Corporations

In the first step of HCA, an exploratory, inductive analysis was conducted to identify all responsibilities mentioned in the essays, and to sort and classify these into thematic structures. From this analysis, we identified 19 themes, that could be subsumed into four dimensions: business operations, economics responsibilities, social responsibilities, and environmental responsibilities (Table 1, p. 23).

The predominance of themes associated with business and economics, i.e., business practices and economic responsibilities, is unsurprising given the nature of the essay questions on the role of corporations and the academic subject area of the respondents. Of interest is that we can identify the three dimensions of sustainability—economic, social, and environmental spheres, and a fourth, namely business operations, a theme associated with responsibilities that are clearly dissociated from economic responsibilities. Interesting also is that, although present, the environment is by far the least developed thematic dimension. Finally, it is also worth noting that references to ethics and philanthropy were mostly absent among our 80 respondents, which is interesting, considering how central the concepts of ethics and philanthropy are in the academic literature on CR. Accordingly, the results of CCA provided us with an overview of the different thematic dimensions of responsibilities evident in our data. In the next step, we explored how the themes identified in the essays relate to each other based on MDS modeling.

Table 1. Thematic dimensions of the responsibilities of large corporations.

Business Operations	**Economic Responsibilities**
– Employment – Employees – Corporate Relationships – Ethics – Sustainable Development – Innovation – Role Modelling	– Profits & Shareholders – Corporate Development – Create Value – Tax – Economy – National Governance
Social Responsibilities	**Environmental Responsibilities**
– Social Development & Stability – Social Responsibility – Social Hot Spots – Philanthropy – Give to Society	– Environment

4.2. Results 2, HCA Step 2—MDS: Mapping the Thematic Dimensionality of Corporate Responsibility Expectations among Advanced Business and Economics Students in Beijing

To explore contextual and cultural influences on corporate responsibility expectations, we modeled an underlying structure of the themes identified in the previous step, based on the co-occurrences of themes within each essay. We did this by plotting the themes from the qualitative analysis using MDS. Figure 1 (p. 25) shows a detailed representation of the resulting MDS map.

Figure 1 can be interpreted as a collective mental map, reflecting the CR expectations of our 80 respondents. The layout of the themes—represented by the distances between the points in the diagram—are indicative of how often themes co-occur. Themes in close proximity tend to co-occur frequently, while themes further apart co-occur rarely. The closer the themes are to each other, the more frequently they are associated with each other in the essays. For example, the theme labeled 'innovation' is close to 'giving to society' and 'employment', implying that when respondents refer to industrial or business innovation as a form of corporate responsibility, they associate it with creating employment and contributing to Chinese society. The opposite is true for the themes 'innovation' and 'role model', since they are at opposite ends of the map. The distance between the two points implies that ideas subsumed under the theme 'innovation' are least likely to co-occur with ideas subsumed under the theme 'role model'. In other words, our respondents tend to think of the responsibility of being innovative and inventive as something that is in opposition to conforming to corporate role expectations. Finally, we can see from the scatter of the themes that there are no clear, separated clusters, illustrating the high interconnectedness of the themes identified by CCA.

Figure 1. Multidimensional Scaling (MDS) output of the thematic dimensions of corporate responsibility expectations.

4.3. Results 3, HCA Step 3: Connecting CR Expectations to Corporate Roles

Next, we analyzed the associations between themes. According to the MDS output, we are able to identify corporate roles that describe the main CR expectation dimensions. These corporate roles are indicative of an underlying understanding of the responsibilities of corporations. Corporate roles as presented here are not distinct or mutually exclusive. They represent the connections between themes. Figure 2 (p. 26) provides a visual representation of the layout of eight corporate roles. They are loosely structured in the shape of a horseshoe, formed by a base at the bottom with two arms extending outward on each side. In the following section, we first examine the various corporate roles individually before we interpret the overall structure. Our interpretation of the MDS map is assisted by referring to the relevant raw data, which helps in interpreting the relations between the individual themes and associated corporate roles, as shown by the MDS map.

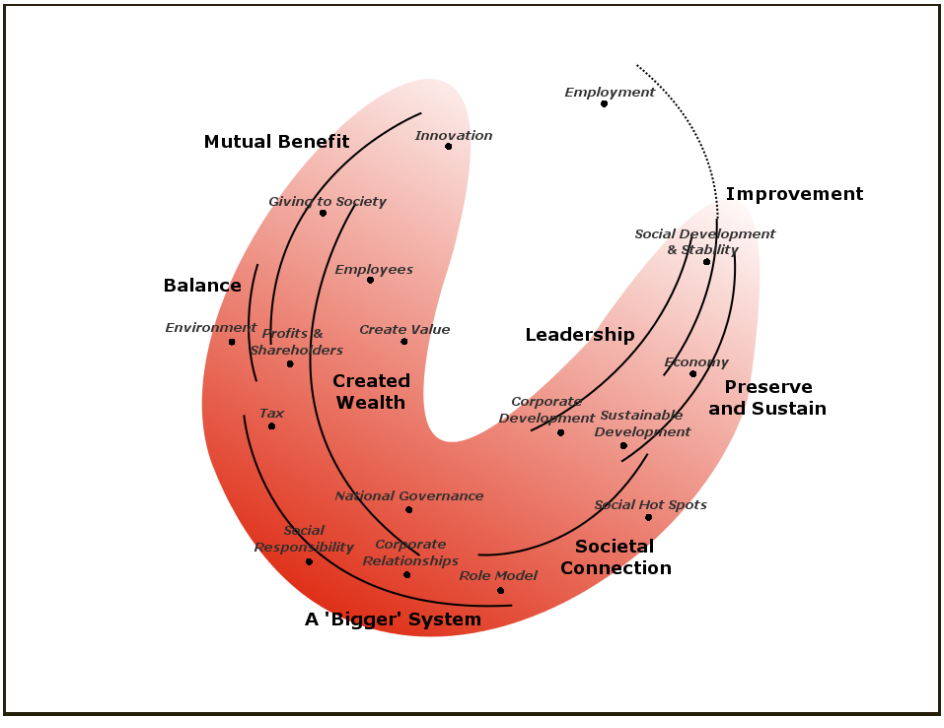

Figure 2. MDS output of the thematic dimensions of corporate responsibility expectations, the horseshoe (red), and the corporate roles (black).

4.3.1. Foundations of CR

A 'Bigger' System

At the bottom of the horseshoe are four interrelated themes that make up the base of the horseshoe, namely Tax, Corporate Relationships, Social Responsibility, and National Governance. These four themes, labelled A 'Bigger' System suggest that corporate roles are defined and located within Chinese society. Responsibilities in this part of the horseshoe connect three major actors—the state, society, and the business sector. Corporations are viewed as an integral part of this larger, interdependent meta-system, that includes the government and society. Responsibility is associated with the size of the corporation: the larger the corporation, the larger its responsibility toward the government and society. This includes, for example, that large corporations have a responsibility to ensure the proper functioning of the nation, such as to uphold and advance this meta-system. Corporations can do this by paying taxes, generating wealth for the nation, closely collaborating with government, and

fulfilling their role as one of the primary economic actors in the market economy. Here are some examples from the essays that illustrate this point:

> A large corporation should make use of its size, resources and capital to undertake social responsibility on the premise of maintaining its self-interest. Besides, corporations should provide technology and capital to support upstream and downstream firms. Finally, corporations' actions should be in line with government policy; donate when natural catastrophe occurs. Corporations are the basic element of modern commercial society. Large corporations have more advantages and privilege (such as monopolization, centralization, favorable policy) to support their development. Hence, large corporations should fulfill their obligations and social responsibility while enjoying their rights. Doing such things also can help the corporation to avoid some unknown risks that could harm their reputation. (39-1&2)

> Create profit for the State. As the main body of the nation's economy, large corporations make contributions to the State through creating profit. Large corporations are the organic component of the whole society rather than an entity that is isolated from society. Hence, the Old Saying "With great power comes great responsibility", after reaching a certain scale, corporations must take on some social responsibilities. From a corporation's perspective, these responsibilities help to support the long-term development of the corporation. From the nation's perspective, if large corporations refuse to undertake these responsibilities, it will create instability in the nation. If large corporations do not take the environment into consideration, declare bankruptcy whenever they want, cut down the staff as they want, only care about their profit, it will bring disorder to the society. (33-1&2)

> Large corporations control the most state resources. Size is proportional to responsibility. (7-2)

Similar to the base of a horseshoe, this corporate role lays out the foundation upon which CR expectations are built. In this way, corporations are viewed as one of three cornerstones of Chinese society. They stand in dutiful relation to the state and society within this interdependent meta-system, continuously making and repaying debts. CR expectations are grounded in the central position corporations occupy, and the CR goals and aspirations of the nation are built onto this foundation.

4.3.2. CR Means

The connections and interrelations of themes on the left side of the horseshoe may be understood by three corporate roles, namely Balance, Created Wealth, and Mutual Benefit.

Balance

Balance subsumes fives themes: Employees, Environment, Create Value, Profits, and Shareholders. These themes connect with each other to make up a corporate role that centers around balancing different outcomes. Essentially, it encapsulates the idea that the role of corporations should include but not be limited to the maximization of profit. Rather, it should be extended to also include the interest of other stakeholders, as well as concerns for the environment. In other words, to engage responsibly in ways which balance the generation of profits while avoiding harm. Here are some examples that illustrate this corporate role:

> The responsibility of large corporations means that the activities of corporations should follow the development of people, nature, and society. In other words, the corporation should not blindly pursue self-benefit through damage to society and the natural environment. (12-1)

> First, internal responsibilities: responsibility for shareholder profit, for employees, and for management. Second, external responsibilities: responsibility for society, for the environment, for the community, for clients, and for the welfare of society as a whole. (9-1)

> Their development also leads to many negative influences, such as pollution. They need to pay for these damages to the environment and society. (64-2)

Created Wealth

Created Wealth includes the themes Giving to Society, Employees, Environment, Create Value, Profits and Shareholders, Tax, and Corporate Relationships. It is based on the notion that corporations ought to share the wealth they create with those who helped to create it. This responsibility set connects to employees on the one hand, because of their direct participation in wealth generation, but also to a more general, societal entity. Accordingly, corporations have the responsibility to share accumulated wealth in order to ensure the wellbeing of the country and its citizenry, and to actively participate in, provide for, and improve society. This is because wealth and success of corporations are often portrayed as the consequence of years of societal support that allowed corporations to use significant social resources to achieve growth and success. Here, resources refer to financial resources, human resources,

communal facilities, government assistance, subsidies, tax relief, infrastructure development, etc. Given the advantages and resultant success of corporations, they now have an obligation to return this wealth to the societal stakeholders who enabled it. Here are some examples:

> The profit corporations generate come from people, so they should absolutely benefit people. Corporations will find it difficult to develop without the support of people and the nation; the corporation's main mission is to create value for its shareholders. Besides, if corporations lack the support from their employees, it will be hard for them to achieve sustainable development; the early stages of our reform strategy stated "to allow some people to get rich first, and later on the rich will drive our development forward for all, and then lastly we will achieve common prosperity". So, the nation gave corporations many privileges to support their development and that is why corporations should fulfil social responsibility, to return to society. (79-2)

> The basic mission of a corporation is to make profit and most of it is created by employees, so corporations should share the profit with the employees in order to encourage them; large corporations should realize that with great power comes great responsibility. Otherwise, a corporation's development also depends on its surroundings, so corporations should make a contribution to society. (22-2)

> Create value for shareholders; create benefit for society; provide a platform for employees to develop themselves. From the corporation's perspective, the purpose of a corporation is to make profit and create value for shareholders; meanwhile, the corporation is a member of society and has the responsibilities to make a contribution to its environment; to provide a growth platform for employees is also a reflection of a corporation's social responsibility. (38-1&2)

> To create value, corporations occupy social and public resources, so it is their responsibility to pay back to the society. (6-2)

> Create and share value with society. (42-1)

Mutual Benefit

This corporate role includes the themes of Innovation, Giving to Society, Employees, and the Environment. While the previous corporate role connected to the concept of wealth and who it should be shared with, the corporate role of Mutual Benefit provides the blueprint for how this wealth should be shared: by

creating mutual benefit for all. Similar to Created Wealth, a prominent justification for corporations to engage in mutually beneficial practices is that large corporations use considerable resources, from which arises the responsibility of giving back to society. Present also are key stakeholders, namely employees, the environment, as well as society as whole. This corporate role, however, lays down various strategies and examples for how benefits should be shared. These include improving staff benefits and providing a platform for growth for employees through educational and skill training. In this business role, technical innovation is seen not only as an important business strategy to further the development and market share of corporations, but it is also framed as a vital contribution toward a successful society by benefiting employees and contributing to the growing wealth of society. Technological advancements by corporations are seen as a public good, although it is initiated, developed, and implemented by corporations. The purpose of innovation, according to our respondents, is to increase the quality of life for all citizens by making life easier and more efficient, and by creating mutual benefit for all. Here are some examples:

> Make a contribution to society, such as environmental protection or job security; focus on technical progress and cultural development. Large corporations are an important part of society and they should use their influence to benefit society. In conclusion, with great power comes great responsibility. (50-1&2)

> A large corporation can improve its products and services to increase the welfare of the public; promote society's level of technical innovation in order to escalate social efficiency. Large corporations are members of society, it is their duty to undertake social responsibility; large corporations are technologically advanced which could build a creative environment to promote the level of technology in society as a whole. (52-1&2)

> Make a contribution to society, such as environmental protection, public welfare, employee development, and so on. (20-1)

> Large corporations occupy a significant proportion of high-quality social resources, so it is their duty to give back to society; large corporations also gathered highly qualified people, they have the capability to advance technical research and development which can benefit both society and the corporations themselves. (32-2)

The three corporate roles presented here reflect strong collectivistic ties wherein corporations occupy a central position within a larger, interdependent collective

meta-system, which includes the business sector, communities, society as a whole, the state, and the environment. According to these corporate roles, corporations ought to align their goals, objectives, skills, and resources toward the greater good of the collective. Such an alignment will reconfirm the commitment of the other components of the meta-system to contribute resources toward the success and wellbeing of the corporation. The CR expectations upon which these corporate roles are based provide the blueprint for how CR goals and ideals can and should be achieved—the means to an end. Accordingly, when corporations aspire toward balanced outcomes, share the created wealth with those who have helped to create it, and leverage their skills and resources to bring mutual benefit to all, then CR goals are realized.

4.3.3. CR Ends

On the right side of the horseshoe, there are four corporate roles, namely Societal Connection, Leadership, Preserve and Sustain, and Improvement.

Societal Connection

This corporate role includes the themes Role Model, Corporate Development, Social Hot Spots, and Sustainable Development. It is built on expectations for corporations to foster their societal connection by integrating themselves into local communities, participating in public activities, allowing the public to participate in corporate affairs, and helping the government to establish, maintain, and increase social security systems. One way they can do this is by focusing on so-called hot spots in Chinese society. In our data, hot spots refer to sensitive societal issues or trigger points, which need special care to ensure public stability and societal welfare. CR expectations in relation to these hot spots include, for example, helping vulnerable social groups and the poor, investing into local communities and social needs, and improving the quality of life for citizens. It is understood that taking on social responsibilities will create more value for large corporations since these close societal ties will be beneficial in shaping their public image and developing a good reputation. Embedded in this corporate role is the notion of a reciprocal relationship between corporations and society. On the one hand, engagement in societal issues ensures the reputation and legitimacy of the corporation in society and, as a consequence, positively impacts corporate development. On the other hand, it creates a role model for society, which fosters responsible behavior among other societal actors. Here are some excerpts illustrating these points:

> Large corporations should play a positive role in social affairs through integrating themselves into their local community and donating to charity organizations in the region. (69-1)

> Pay more attention to the disadvantaged; help the government to establish a social welfare system, to ensure a wider coverage and a larger number of benefited people. . . . The reputation of large corporations can be effective in creating a large range of social benefits; their social image can cause other members in society to take on social responsibility thus creating a social sense to promote social development in all aspects of society. (8-1&2)

> Responsible companies are accepted by the employees, clients, and society. Taking on responsibilities will promote their development, improve their productivity, and increase their profits. (9-2)

> Build an organization which the public can join and supervise. (60-1)

> Companies can be examples in many aspects, such as showing integrity, charity, and caring for the retired. (7-1)

> . . . even spread a new culture or positive energy to society as a whole. . . . Finally, through fulfilling its responsibilities, the company will transfer this positive mental power to society as a whole. (10-1&2)

Leadership

Leadership as a corporate role includes the themes Corporate Development, Social Hot Spots, Sustainable Development, Economy, and Social Development and Stability. It captures the idea that corporations should take on a leading role in the development of industry, as well as in economic and social development, given their central, powerful, and privileged position in China. In this way, decision-making processes and business activities should aim to develop a corporate culture, which cultivates socioeconomic development. Providing quality products and services, for example, fosters the development of the company and the economy at large, which supports the socioeconomic development of society. Connected to this are the notions of leadership versus competition. Even though market competition is mentioned as being part of corporate strategy, there emerges in the data a distinct expectation of leadership and cooperation. Fulfilling responsibilities as leaders of industry simultaneously promotes the continual development of these corporations while also improving society and the economy as a whole:

> Therefore, besides economic benefit, large corporations should also consider social benefit while making decisions. (14-1)

> Provide quality products and services to support the development of society and the economy. (44-1)

> When large corporations fulfil their responsibility, it can help to develop a corporate culture that supports its sustainable development. (68-2)

> Large corporations play a primary position in the market economy of a socialist country, so they should undertake the responsibility of economic development. Besides, state-owned enterprises should preserve and increase the value of state-owned assets and accelerate economic restructuring. (75-1)

Preserve and Sustain

This corporate role includes the themes Sustainable Development, Economy, and Social Development and Stability and is based on the expectations that it is the responsibility of large corporations to promote a successful market economy and in doing so, preserve and sustain social stability. Some of these responsibilities include sustaining market order, stabilizing prices, maintaining sustainable levels of development and competitiveness, and steady social and economic development on a societal level. As a corporate role, it encapsulates the goal of sustainable development and connects to all levels of society. Because of the contribution corporations make, they can ensure that the national development of the economy, society, and industry, as well as their own are preserved and sustained. Here some examples:

> Stabilize the social and economic order; promote economic development. Similar to bellwether, which can lead the flock of sheep to go forward, large corporations can play an important role during the process of economic development. On the other hand, large corporations have a deep impact on society, so they should make use of this influence to undertake social and economic responsibilities. In conclusion, with great power comes great responsibility. (40-1&2)

> Large corporations play an important role in social development, the implementation of corporations' responsibility can ensure plenty of people's lives and then maintain social stability. (5-2)

> China needs to develop sustainably despite a shortage of resources under such a large population. (60-2)

> Promote the development of society and industry. These responsibilities are good for a corporation's long-term development. (49-1&2)

Improvement

Improvement as a corporate role includes the themes Economy, Social Development and Stability, and Employment. This final corporate role extends the goals of preservation to the central role of corporations to ensure continued

socioeconomic progress. The goal of maintaining China's developmental trajectory and ensuring its continued growth is seen as an integral responsibility of corporations because they possess the necessary resources and capabilities. Also, by pursing these responsibilities, corporations do not only enhance society and the economy but also benefit through the improvement of society and the economy. Corporations can do this by promoting the development of local industries and the economy, solving employment problems through job creation, and contributing to social progress. Here are some examples:

> Large corporations should take on social responsibility and make contributions to support social progress; large corporations should pay attention to social benefit rather than only caring for their own interests; solve the employment problem. Because large corporations have enough resources to influence society, therefore, they should prioritize social responsibility. (47-1&2)

> The nation and society provided a platform for corporations, so corporations ought to provide more job opportunities in return to society; every corporation has the responsibility to promote economic development. (78-2)

> The social behaviors of corporations have significant influence on society's progress and lack thereof; only large corporations can undertake the responsibility of pushing the progress of society forward, in that way, the economy and society can become much better than before. (17-2)

> Large corporations should comply with local law and provide more job opportunities, besides; they should accelerate economic development and increase social welfare. As an essential component of society, they should give back to accelerate the development of society and mankind in order to improve themselves. (66-1&2)

> . . . the third responsibility is to solve the employment problem in order to maintain social stability; the fourth responsibility is to change people's lifestyles. Large corporations occupy a lot more social resources, so they should take on relevant social responsibilities; the corporation is one of the important powers to promote social progress. (16-1&2)

Most CR expectations reported by our respondents reflect different CR goals or ideals. In Societal Connection, for example, the goal of CR is to become responsible societal role models. By integrating into local communities and by helping the government to provide and maintain social security systems, taking care of vulnerable groups as well as addressing societal hot spots, they set an example

that others will follow. This connects to the strong Leadership role corporations are expected to embrace. As a CR ideal, corporations are expected to lead the development of technology, the economy, and society. Two further CR goals relate to preserving the success, which has been achieved thus far, and ensuring the continued socioeconomic progress of the nation. Where the previous corporate roles on the left side of the horseshoe laid out the means with which to reach the end, the corporate roles on the right side lay out the various responsibilities that capture this end, i.e., the goals of CR as it is or as it should be.

4.3.4. Making Connections

The themes at the base of the horseshoe form the foundation of CR expectations. They position corporations as central actors with responsibilities and obligations toward a much larger, interdependent meta-system. Accordingly, corporations do not only have responsibilities toward their senior managers, shareholders, customers, and employees, but also in relation to other stakeholders, including Chinese society and the state. CR expectations within this bigger system are defined by means and ends. On the one hand, the ends of CR include connections to society in that they not only build strong and trustworthy reputations, but that their actions set the benchmark for how others should behave; that they should lead by developing business practices and corporate cultures, which emphasize socioeconomic development of all sectors including the economy, society, and industry; that it is their task to ensure that this is part of a sustained effort; and that they realize their role in a continued improvement of the country's developmental trajectory. On the other hand, the means through which these CR ends can be achieved include, for example, that corporations are expected to balance profit generation with accounting for the impact they have on the environment and society; that the wealth which has been created should be shared not only with shareholders but also with employees and society more generally; and that this should be done through various initiatives and by leveraging innovative technology to benefit the environment and society.

4.4. Results 4: Additional Findings

Two additional findings, both relating to public relations (PR), merit mentioning. Both illustrate how CR notions are uniquely developed, extended, and manifested in the Chinese context.

Public Relations

In our data, we find a strikingly different notion of public relations (i.e., via a role model), which contradicts PR in the Western sense. PR in the sense of role modelling is characterized by strong reciprocity. Role modelling is not only concerned with

making the public aware of corporate actions and strategies and thus creating a positive public image but also with setting the benchmarks for how other societal actors should behave through exemplary corporate conduct. By constructively addressing or avoiding social hot spots, CR strategies ostensibly have the ability to develop and transmit positive social values, teach cooperation and consideration, and instill care for all members of society.

In this regard, it is also interesting to note that a more global perspective is almost entirely missing from our data. Except for a single reference to how Chinese corporations are expected to lead globally, any reference to international linkages or global expectations are absent. Instead, perspectives on CR tend to be nationalistic and inward looking, focusing on the role of CR within the meta-system bounded by the Chinese nation. Even environmental concerns are limited to the wellbeing of the Chinese citizenry, the health of the workforce, or the reduction of health costs for the state. As such, corporate roles in association with CR expectations conceptualize an interdependent meta-system bounded by a national system.

Creating Value

Value creation is also developed in an interesting way. In our analysis, Create Value extends well beyond the notion of market share increase or profit generation. It is the most connected theme in the horseshoe, connecting in some way to nearly all of the corporate roles discussed in this paper. For our respondents, value creation transcends profit and market share; it is embedded in multiple layers of society. It is not only viewed in monetary or market terms relevant to the corporation, but also in terms of socioeconomic development, environmental sustainability, and mutual benefit. As such, creating value is not a corporate goal, but a societal and national one.

5. Discussion and Conclusions

From systematizing the CR expectations of our respondents from Beijing, we were able to identify a variety of cultural and contextual characteristics embedded within their expectations of the role that corporations play or ought to play. We observed multiple, distinct references toward collectivism, where group membership, social relations, mutual benefit, and the contribution to the national wellbeing are or are expected to be constitutive of corporate behavior. However, this collectivism integrates in interesting ways the pursuit of technological innovation, efficiency, and profit. As size is associated with collective duty, the larger and more powerful the corporations, the more responsibility they are expected to assume, and the more support they are to expect from society and the state. Collectivistic values are also evident with reference to CR expectations that encourage cooperation, cohesion, and harmony, especially in relation to promoting and maintaining social stability. Corporations are an integral and interdependent part of a meta-system

that includes society, the state, and the environment, and our respondents equally viewed themselves and members of Chinese society as part of the meta-system with all its duties and privileges. Except for a few mentions of profits, shareholders, and competition, individualistic values such as self-reliance and personal gain are uncommon, as are expectations associated with globalization, competition, or Western consumer lifestyles. This is not to say that these are absent from the lives of our Beijing respondents. Rather, they do not seem to be prominent in relation to expectations they have of corporations. The one Western concept that was mentioned by our respondents again and again is the saying 'with great power comes great responsibility', made famous by the Marvel superhero character, Spiderman.

Beyond these cultural characteristics, there are various contextual elements that circumscribe the CR expectations of our sample. Perhaps the most important of these is the emphasis on the role corporations ought to play in relation to national governance. Not only are they expected to comply and cooperate with the state, but they are also expected to contribute to and further develop state resources, to help realize national long-term goals, foremost among them the socioeconomic development and prosperity of the Chinese nation. Corporations are also recognized as one of the primary actors through which social development can be achieved. Interestingly, these responsibilities and expectations are not imposed on corporations but are based on assumed reciprocal relations, where success, wealth, and stable growth of the corporation is achieved by collaborating with a socioeconomically developing nation, which, in turn, assists corporations to further achieve success, wealth, and stable growth. The nation is expected to help corporations to be or become successful, and the corporations in turn helps society to prosper.

Even though we expected our respondents from Beijing to touch on dimensions associated with Western conceptions of CR, particularly due to their exposure to the academic literature and their considerable ability to ingest and regurgitate large quantities of academic texts, there were no apparent or overt mentions of academic theories, constructs, or ideas. Instead, the emphasis rests on corporate success as part of socioeconomic development and vice versa. We also find, unsurprisingly, that CR expectations associated with the environment are underdeveloped, usually subordinated to societal needs or, if it appears in its own right, as a vehicle through which social goals can be achieved. In other words, improving the environment is valued not in itself but because it will benefit society or the employer by developing marketable technologies, improving public health, or strengthening the health or commitment of the workforce. Also, by connecting ideas of sociopolitical stability, for example, in the form of avoiding hot spots, with socioeconomic development and growth, this sustainability pillar is best understood within the contemporary Chinese context.

From the perspective of developed economies, business ethics is often presented normatively, as something that corporations ought to engage in—because it is the right thing to do. This is not the case in our data. Even though there were some mentions of responsibilities that seemed similar to Western notions of ethics, such as, "fairness", "transparency", and "honesty", we find these references deeply embedded in a meta-system of interdependence. Our respondents did not refer explicitly to business ethics because they formed an underlying basis of corporate responsibility expectations and are thus omnipresent.

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Determinants of Sustainable Business Model of Companies Early Stage of Development

Marek Jabłoński

Abstract: This paper presents the findings of research on companies in the early stage of development based on the concept of ensuring their sustainability. The starting point are attributes that shape a sustainable model of start-ups. A solution has been proposed and examined that identifies the dynamic factors of business models, which enable the company to make fast changes in the configuration of the business model, and that apply stabilizing factors based on the concept of the "triple bottom line". The research problem is a response to the phenomena of the bankruptcy of many start-ups that cannot find a way to survive in the long term. The business models of companies in the early stage of development should be designed to take into account the possibility of their dynamic and iterative changes when earlier assumptions turn out not to work upon implementation. A cognitive gap has been observed as the relevant literature does not propose a systemic solution to the problem of instability of the start-ups viewed from the perspective of the business model concept. The research problem, therefore, is to identify potential new methods to ensure the sustainability of young companies trying to combine dynamic aspects of business models, taking into account economic, environmental and social aspects. The findings of research on companies in the early stage of development show that when the methods of increasing the flexibility of the business model are applied and attention is drawn to environmental and social activities and a strong emphasis is put on financial performance, reflecting the expectations of shareholders, the concept of ensuring the sustainability of young companies from the point of view of sustainable business model attributes emerges.

Keywords: start-ups; business model; sustainable business model; early stage of development; changes of business model; triple bottom line

1. Introduction

Business models of companies in the early stages of development are exposed to many risks that arise from their maladjustments to market expectations. Business models should have the ability to capture value from the market. In classical terms, the concept of sustainable management refers to the achievement of economic, ethical

and environmental objectives. However, the managers of young companies in the early stages of development rarely think about this triad—the most important thing for them is to survive and achieve the expected success. This paper presents the concept of the combined use of Real Options Theory and the Lean Start-up method in the process of adapting the business model of companies in the early stages of development to achieve a sustainable business model status. It shows how to pivot the structure of business models. Assessing the ability to make dynamic changes in genotypes of business models is an interesting topic of scientific exploration and practical implementations of the sustainable business model concept. The approach may contribute to the development of the sustainable business model concept, in particular for companies in their early stages of development. The author wants to fill in the gap observed during the search for the factors that determine business models development of companies in the early stage of development in terms of a dynamic ability to modify the business model and following the principles of the "triple bottom line" concept at the earliest possible stage of development. When this proposal is supported by the principles of the triple bottom line based on social, environmental and financial aspects, these opportunities can be expanded but the principles contained in this concept should be incorporated into the business model genotype. This combination will enhance the chances of survival of young companies. The use of real options is important for flexible management of a start-up's development. The use of real options when making investment decisions, particularly in the process of initial development of a business model, can significantly increase the flexibility of the approach and neutralize uncertainty. The number of variables that affect the success or failure of a new business venture is so large that any method should be used to reduce business risk. The common use of the Real Options Theory and the Lean Start-up method can help managers to harness the factors determining the need to adapt the proposed business solution to market needs and ensure the possibility of creating shareholder value through the efficient and effective implementation of an innovative business model.

This paper is structured as follows: After the introduction (Section 1) and the discussion of sustainable management in business models (Section 2), it discusses young start-up companies and their life cycle (Section 3). Section 3 deals with the Lean Start-up method as a tool for implementing rules of a sustainable business model. This analysis provides the basis for a discussion of the thesis that making quick pivots in the business model according to the principles of the Lean Start-up method increases management flexibility and opens new spaces to search features describing a sustainable business model of the company in the early stages of development. Section 4 deals with real options in business models. This section shows that the application of the Real Option Theory in managing young companies could be considered as a new way of building sustainable business

model assumptions. Section 5 presents the problem of the conceptualization of a sustainable business model for start-ups. It offers a proposal to make business models flexible and focused on social responsibility issues, which should contribute to the survival of not only large companies but also of start-ups. This section shows that a sustainable business model is a model that reduces the risk of failure and enables the company to make changes quickly in order to achieve business goals, even if the initial assumptions have become significantly obsolete. Section 6 presents the objectives of research, which is based on qualitative and bibliographic research and research findings. Research covered a selected renewable energy company listed on the NewConnect Alternative Investment Market AIM in Warsaw, Poland. Finally, Section 7 presents the conclusions, summarizing the core findings of this paper.

2. Sustainable Management in Business Models

The late 1990s saw the first attempts to identify business models and to define performance measures to describe them. Research in this field was pioneered by Slywotzky who described 22 profitable business models based on experiences of US American companies. He paid attention to one of indicators of description of effectiveness of a business model; namely, the ratio of market value and turnover [1].

The component approach is of particular importance in the process of analysing business models since components shape the business model configuration and underpin its entire philosophy. Table 1 shows selected approaches to the division of the business model into components that are presented in the relevant literature. In this perspective, the business model configuration is essential. In the opinion of Jabłoński, it is the combination of carefully selected business model components that ensures an increase in company value in the given internal and external company environment. Theoretically, it can be assumed that a business model component should function only if it either directly contributes to the increase in the value and/or it is essential to ensure the consistency of the business model [2] (p. 398).

Table 1. Components shaping business models [3].

Author	Specific Components of Business Models
Horowitz (1996)	Prize, product, distribution, characteristics of organization and technology.
Viscio and Pasternak (1996)	Global competence, corporate governance, business units, services, connections of units.
Timmers (1998)	Product/service, flow of information, business actors and their roles, benefits for the actors, sources of proceeds, marketing strategy.
Markides (1999)	Product innovations, relationships with customers, infrastructure management, financial aspects.
Donath (1999)	Understanding of customer, marketing tactics, corporate governance, the Internet and Intranet possibilities.
Gordijn et. al. (2001)	Actors, market segments, value offer, activity of value, network of stakeholders, interfaces of values, changes of values.
Linder and Cantrell (2001)	Prize model, income model, model of business processes, online trade possibilities, organizational forms, value offers.
Chesbrough and Rosenbaum (2000)	Value offer, market targets, structure of inner chain of values, structure of costs, profit model, value network, competition strategy.
Gartner (2003)	Market offer, competences, investing in key technologies, annual net profit/loss (bottom line).
Hamel (2001)	Key strategy, strategic resources, value network, customer connections.
Petrovic et. al. (2001)	Model of values, model of resources, production model, model of relationships with customers, income model, model of capital, market model.
Dubosson–Torbay et. al. (2001)	Products, relationships with customers, infrastructure and network of partners, financial aspects.
Afuah and Tucci (2001)	Value for the customer, range, price, incomes, activity connections, implementation, capabilities and balance.
Weill and Tucci (2001)	Strategic objectives, value offer, income sources, success factors, distribution channels, key competences, customer segments, IT infrastructure.
Applegate (2001)	Concept of capabilities and values.
Amitt and Zott (2001)	Transaction contents, structure of transaction, corporate transactions.
Alt and Zimmerman (2001)	Mission, structure, processes, incomes, compatibility with law, technologies.
Rayport and Jaworski (2001)	Value cluster, market range of the offer, system of resources, financial model.
Betz (2002)	Resources, sale, profit and capital.
Magretta (2002)	Market objectives, value offer, costs, profits, customer benefits.
Von der Horst et. al. (2002)	Network of deliverers' value, value offer, capabilities and competences, support, infrastructure, specific characteristics.
Hogue (2002)	Network of suppliers' value, market objectives, evaluation of resources, incomes, strategy, courses of production/services processes, differentiation, mission, customer benefits, environment, company identity, company reputation.
Chesbrough (2003)	Network of suppliers' value, market objectives, evaluation of resources, value offer, competences and capabilities, costs, strategy.
Hedman and Kalling (2003)	Network of suppliers' value, evaluation of resources, value offer, capabilities and competences, processes, competitiveness, initial offer
Osterwalder and Pigneur (2010)	Design of business model components.
Teece (2010)	The essence of a business model is in defining the manner by which the enterprise delivers value to customers, entices customers to pay for value, and converts those payments to profit.

The presented components proposed by various authors show the interdisciplinary nature of business models. With such a holistic approach for business models, the assumptions of sustainable management should also be taken into consideration.

The sustainable business model concept is based on two pillars: First, the neoclassical economic paradigm is contrasted with sustainability concepts to formulate prescriptions for corporate sustainability. This concept was presented by Lüdeke-Freund [4] (p. 33). As proposed by Stubbs and Cocklin [5], organizations adopting a sustainable business model must develop internal structural and cultural capabilities to achieve firm-level sustainability and collaborate with key stakeholders to achieve sustainability for the system that an organization is part of. In the relevant literature, several approaches to defining a sustainable business model can be distinguished.

There is no unambiguous definition and agreement about the concept of sustainability in the relevant literature. Various terms are used in different interpretations such as sustainability, business model sustainability, sustainability business model, sustainable business model, sustainable business, business case for sustainability. According to Stubbs and Cocklin [5], a sustainability business model is a model where sustainability concepts shape the driving force of a company and its decision making. According to Schaltegger, Hansen, and Lüdeke-Freund [6], a business model for sustainability helps describing, analysing, managing, and communicating a company's sustainable value proposition to its customers, and all other stakeholders, i.e., how it creates and delivers this value, and how it captures economic value while maintaining or regenerating natural, social, and economic capital beyond its organizational boundaries. They argue that by extending the conventional view of a business model designed around a value proposition for customers, we acknowledge that no sustainable value can be created for customers without creating value to a broader range of stakeholders. A business is carried by a stakeholder network, and—in spite of the fact that a business model is a market-oriented approach—particularly a business that contributes to sustainable development needs to create value to the whole range of stakeholders and the natural environment, beyond customers and shareholders. With regards to business cases for sustainability, also proposed by Schaltegger, Lüdeke-Freund, and Hansen [7], they point out that business cases for sustainability may be worthwhile to move from single and event-driven business cases for sustainability to business models for sustainability that serve as templates for reproducing the respective business cases on a regular basis. In other words, moving from single to continuous business case creation may be supported by a business model rationale which positions sustainability as an integral part of the company's value proposition and value creation logic [7]. A sustainable approach to business provides a range of new

possibilities of creating modern business models. Jabłoński [8] defines a sustainable business model in the context of building long-term value of a socially responsible company. It is a holistic model built by the joint use of the corporate social responsibility and value based management concepts that ensures that the needs of shareholders and other stakeholder groups are fulfilled, through the skillful balancing of a company's potential towards generating value allocated in a sustainable way, enabling continuity of company management [8] (p. 402). The approach proposed by the author is in line with the assumptions of the neoclassical paradigm in economics but with intensive pro-social and environmental activities for the purpose of long-term survival and development. Grudzewski, Hejduk, Sankowska and Wańtuchowicz [9] argue that sustainability is the ability to provide continuous learning, adaptation and development, revitalization, reconstruction, reorientation to maintain a lasting and distinctive position in the market by offering buyers value today and in the future with an organic variation of constituting business models and the resulting creation of new opportunities and objectives and answers at balancing the interests of different groups. In the literature, sustainable business models are usually examined taking into account economic, environmental and ethical factors, in line with the classical approach based on the assumptions of the abovementioned triple bottom line concept. It is crucial to balance the areas related to financial, social and environmental factors to find a way of achieving business success in the long term. One hypothesis holds that a separation of the three areas makes sense at the operational level (i.e., keeping operative economic environmental and social responsibilities distinct), while a strategic decision would only be possible when considering the three dimensions simultaneously [10]. In the area of management studies, several leading trends related to the interpretation of the sustainability concept as outlined above can be seen. Another approach to the issue of sustainability is an approach based on links between different ethical motivations and kinds of corporate social responsibility (CSR) activities that distinguish between different types of business cases with regard to this sustainability. The design of CSR and corporate sustainability can be based on different ethical foundations and motivations. CSR is considered an area of management excellence and corporate sustainability as a management challenge to increase efficiency, quality and performance of the given processes and products. Efficiency gains, costs reductions and incremental processes and product innovations are pursued. A broad range of business case drivers such as cost reduction, innovation (mainly incremental), brand value, or sales are addressed. Technical and organisational excellence is targeted with optimization projects, incentive programmes, cross-disciplinary employee teams and task forces. According to Schaltegger and Burritt [11], this business case, although clearly contributing towards sustainable development, is limited in scope as it focuses on the corporate entity, its products and direct relationships.

Furthermore, a responsible business case for sustainability is incremental as it is created from the logic of the existing operational and business models. Sustainability management refers to approaches dealing with social, environmental, and economic issues in an integrated manner to transform organizations in a way that they contribute to the sustainable development of the economy and society, within the limits of the ecosystem [6]. Another view of sustainable business models is based on an innovative approach [7,12,13]. According to Boons, Montalvo, Quist, and Wagner [12], sustainable development requires radical and systemic innovations. Such innovations can be more effectively created and studied when building on the concept of business models. This concept provides firms with a holistic framework to envision and implement sustainable innovations. An important and interesting trend in research on sustainable business models focuses on financial implications. Carroll and Shabana propose a narrow view of business-justified CSR initiatives when they focus on direct and clear links to firm financial performance. Mostly, a narrow view of business focuses on immediate cost savings. By contrast, a broader view includes CSR initiatives when they produce direct and indirect links to firm performance [14]. The approach to business models from the point of view of a sustainable competitive advantage has been proposed by Morris, Schindehutte and Allen, who argue that the business model is a concise representation of how an interrelated set of decision variables in the areas of venture strategy, architecture and economics are addressed to create sustainable competitive advantage in defined markets [3] (p. 727). On the other hand, an approach based on an analysis of businesses focused on the principles of sustainable business contributes to increasing value for shareholders.

To create sustainable businesses requires strategic management to identify, create and strengthen the links between non-monetary social and environmental activities on the one hand and business or economic success on the other hand. Furthermore, in order to achieve this goal, the formulation and implementation of corporate strategies have to change, compared to strategies that only strive for market sustainability through competitive advantages in the sense of the resource based theory of a company. That is, strategic objectives and measures, and sometimes even the business model of a firm, have to be oriented towards the triple bottom line [15]. Based on these key assumptions one can ask how strategic sustainability management can contribute to creating and managing business cases for sustainability, what drivers it has to address in order to create a business case for sustainability, and how business model innovation can serve as a framework for this endeavour.

The drivers of a sustainable business are variables that directly influence economic success and are therefore related to the drivers of a conventional business case for an overview of performance drivers. However, the links between voluntary sustainability activities and economic success are often different and therefore also

the kind of influence a social or environmental activity has on the economic drivers. Among the core drivers of a business case for sustainability are:

- Costs and cost reduction;
- sales and profit margin;
- risk and risk reduction;
- reputation and brand value;
- attractiveness as employer; and
- innovative capabilities [16] (p. 7–10).

According to Hutchinson, Singh, and Walker [17], factors that shape a sustainable business approach may include elements such as the natural environment, driving forces, purchasing policies, value adding processes, intermediaries and transport, retail practices, marketplace/society. To achieve the effect of sustainability, it is important to apply strategic thinking focused on this approach in the organization. Sustainable business thinking is a holistic approach to thinking about business that seeks to integrate consideration of the three dimensions of sustainability—social, environmental and economic—in a manner that balances or aligns value creation for all stakeholders including the environment and society at all levels and through all activities of the business, as presented by Bocken, Rana, and Short [18] (p. 77).

3. Young Start-up Companies and Their Life Cycle

Young companies determine the vitality of economies. The growth rate of the emergence of creative companies is an indicator of market growth potential and improving macroeconomic indicators. Accordingly, much research deals with the issue of start-ups. Among others, the following works can be distinguished: Churchill and Lewis [19]; Eggers, Lehey, and Churchill [20]; Hanks and Watson [21]; Nanda and Rhodes-Kropf [22]; Scott and Bruce [23]; Paik and Woo [24]; and Adizes [25].

According to Blank and Dorf, a start-up is a temporary organization dedicated to looking for a scalable, repeatable and profitable business model [26] (p. 19). Such a definition clearly indicates start-up characteristics to be:

1. temporality;
2. lack of durability;
3. volatility; and
4. risk and uncertainty.

With reference to the life cycle of young companies, Damodaran defines the following features: no history, little or low revenue and operating losses, strong dependence on investment funds, many of them do not survive, high liabilities

compared to the raised capital, and investments that are not liquid [27] (pp. 5–6). Figure 1 shows the according early stages of the life cycle of companies.

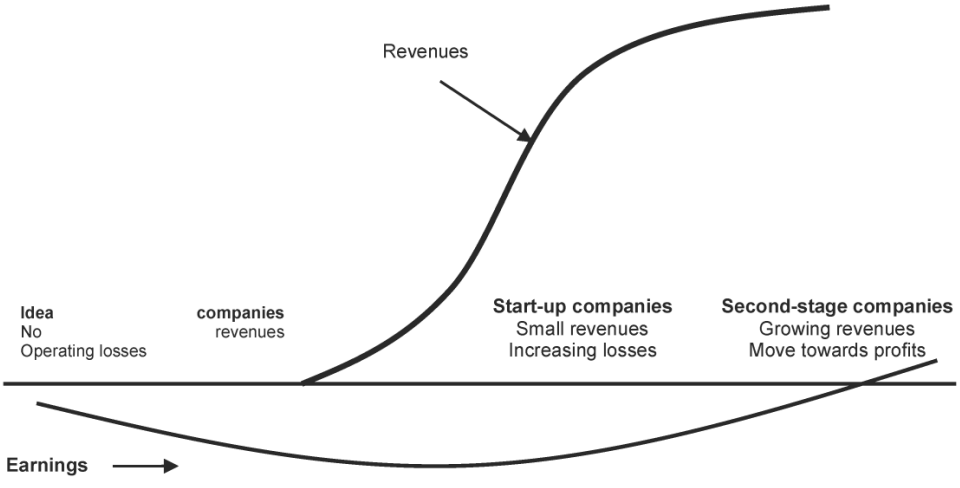

Figure 1. The early stages of the start-up life cycle [27] (p. 4).

At the first stage is a business idea characterized by a lack of revenues and operating losses. While a start-up is being built, revenues grow and in the second stage, revenues increase dynamically, which enhances profits. In reality, this cycle occurs very quickly. After the first stage, some start-ups may feel the need to modify the business model, when the signals from the market confirm the credibility of variables determining a need to verify the idea with reference to the dynamically changing customer preferences. Young companies are particularly exposed to rapid bankruptcy. Based on data from the US American market [28], it is clear that only one third of companies operating in the public and private sectors survived after seven years of their activity. Better results are achieved only by companies in the health and financial services sector. Companies operating in sectors related to new technologies have a big share in bankruptcies. Only 24% of companies operating in the IT sector survived in the studied period [28] (p. 6).

It should be noted that in start-ups not only strategy will determine success, but also a well-designed business model based on credible premises. The data presented leads to the conclusion that there is a need to seek solutions regarding young companies' sustainability, including methods to develop a sustainable business model. Therefore, both in management theory and practice, optimal methods for ensuring the sustainability and success of start-ups are required.

Blank proposes the concept of a lean start-up as a new approach to designing start-up businesses, believing that the founders should not begin by developing a

business plan, but by searching a business model. According to Blank [28] (p. 7), the principles of the lean approach are:

1. Business model—a carrier of hypotheses;
2. Customer development—leaving the office to test the hypotheses;
3. Agile development—developing a product iteratively and incrementally;
4. Evaluation of customer's needs and agile development teams—hiring employees in order to learn, agility and speed;
5. Relevant data—customer acquisition costs and time of delivering value to the customer;
6. Determining iterative ideas and evaluation with reference to those which are affected by them;
7. Work based on data that is good enough.

The presented new approach is a kind of revolution in perceiving the process of marketing new business ventures as it triggers a new way of thinking about business start-ups. This shows that existing management theories and practices are not quite suited for this type of company. Therefore, it is necessary to look for new ways of managing them. At the very beginning of its existence, a start-up is in its essence a big unknown, resulting from such exemplary variables, such as uncertain legal conditions for the functioning of the proposed solution, a product or service that has not been tested yet, a solution that is very often so innovative that preliminary tests cannot prove that it will be able to generate the expected value in the future, an idea based on not fully tested technologies, or technologies that are yet to be developed. A start-up is basically a synonym for a business model that is maturing, changing, adapting to a dynamic external environment, experimenting and making mistakes but with the potential to multiply the capital invested by investors in favourable circumstances. The basic assumption of start-up activity is universal, regardless of industry, i.e., the idea that going beyond existing solutions can benefit and sometimes, in the form of a ground-breaking innovation, change an entire sector. Testing the start-up and as a result learning is used to find a scalable business model that enables the company to achieve the expected results. It should be noted that the fourth assumption of the lean start-up concept described above includes an alternative system of business decision-making. This is where there is a need to obtain information that will help determine whether a start-up should continue with existing activities or not. Such an approach to start-up management is consistent with Real Options Theory. While at this stage business venture should be assessed in terms of risk, there is justification for using real options for this purpose (the option to abandon, the option to expand, the option to contract, the option to defer, and the option to switch). Combining a flexible approach with the dynamic adjustment of the business model in its life cycle can be supported effectively by financial engineering

based on the Real Options Theory. The fifth assumption concerns the use of the assumptions regarding performance management adapted to the specific character of a start-up company. It is justified to identify the measurement needs for individual attributes and the functionality of the business model.

According to Ries [29], creating a start-up business with the wrong approach has been particularly noticeable in recent years. In the earlier epochs, the strategy and business plan were the reason for the likely success. Thus, the temptation is enormous to use them also for start-ups. However, this does not work because start-up companies operate with too much uncertainty. A start-up does not know yet who their customers or what the product will actually be like. Old management methods do not work in this context. Planning and forecasting are accurate only if they can be based on long-term assumptions, and today, they are difficult to predict, notably for start-ups [29] (p. 19). Thus, a business plan is often a key barrier to success. Managers, uncritically implementing previously developed assumptions of the business plan, may omit a number of important issues arising from the volatility of markets and customer needs. The presented approach emphasizes the need for an iterative adaptation of the company's business model based on an analytical approach to the assessment of achievements and progress in the process of marketing a new start-up company. The precursors of this approach point to the problem that start-ups use tools effective for companies that have already found their business model, while a start-up as a whole is reduced to what is unknown. In fact, a start-up can be understood as a bundle of unproven hypotheses [30] (p. 27). According to Ries, the concept of the lean start-up was designed for entrepreneurial assessment, in particular by investors. Ries defines as the five principles of a lean start- up [29] (pp. 17–18):

1. Omnipresence of entrepreneurs. A start-up is based on the fact that new products and services are developed in conditions of extreme uncertainty. This is universal and applies to companies of all sizes and in all industries and sectors.
2. Parallelism of entrepreneurship and management. A start-up is an institution and is not limited solely to the product, and therefore it requires a new management model, prepared for use in conditions of extreme uncertainty.
3. Verified learning as a process. Start-ups are not established just to produce something, earn money and serve customers. They are founded to learn how to build a profitable company. This learning process takes place in the course of numerous experiments that allow entrepreneurs to test individual elements of their vision.
4. Creation—measurements—learning. The core activity of a start-up is to turn its ideas into finished products, to observe and measure customer response and to obtain information that will help determine whether it should continue its

course of action or not. The processes of start-ups should be designed in such a way as to increase the speed of this feedback loop.

5. Innovative accounting. In order to enhance the performance of entrepreneurs and assess innovators based on their actions, it is necessary to focus on ways of monitoring progress, setting intermediate objectives and scheduling tasks. This requires a completely new type of accounting, created specifically for start-ups and their assessment.

The strategy of a start-up is important but its success is determined in particular by the business model and it should be monitored and changed dynamically.

The lean start-up as a management concept and method proposed in the relevant literature assumes that the business and marketing functions of a start-up should be treated as product development, so they deserve an equally systematic management methodology [31]. It is therefore necessary to focus on this new way of dealing with start-ups in order to draw attention to new areas of starting business ventures.

4. Real Options in Business Models

The success of the business model largely depends on the scalability of the technologies and services used. This is due to the fact that common business environments of start-ups are the internet and social communication systems. According to Morris, Schindehutte and Allen [3], it is possible to envision a business model life cycle involving periods of specification, refinement, adaptation, revision, and reformulation. An initial period during which the model is fairly informal or implicit is followed by a process of trial and error, and a number of core decisions are made that delimit the directions in which the firm can evolve [3] (p. 733). To this end, it is reasonable to apply Real Options Theory [30–36]. Trigeorgis [37], the most prominent proponent of Real Options Theory, classifies the behavioural options that underlie the theory as follows:

- The option to defer (or to wait);
- the option to alter the operating scale (i.e., to expand or contract);
- the time-to-build option (or option to stage);
- the option to abandon;
- the option to switch (outputs or inputs); and
- the option to aim for growth.

Real options in business models are often options present in strategic technology ventures, where profit is fully dependent on the creation of new technologies and their specific attributes. An approach based on Real Options Theory links the budgeting processes and strategic decision-making methodology. As a result, an above-average business flexibility is often achieved. Technological business models

easily fit the classification of Real Options Theory as described above. The planned strategic scenarios are based mainly on a technological approach to planning variants described by real options. The Real Options Valuation (ROV) method is particularly useful for the valuation of companies that are characterized by several rounds of investment and a high degree of uncertainty about the future, while profits can fluctuate from bankruptcy to potentially high return. Real Options Theory is based on the common use of the Discount Cash Flow (DCF) method assumptions and techniques of decision analysis that are important, for example, in the process of selling. Venture capital funds divide investments into several sequences just to motivate the management boards of companies to achieve specific goals, making their achievement conditional for further rounds of investment. Dividing the investment into several sequences, an investor greatly reduces risk by waiting with giving more money until he or she obtains specific information [38] (p. 132–133). From a theoretical point of view, options are attractive also because it is possible to achieve flexibility in many investment projects. However, applying the methodology in practice can be challenging as it can encounter many difficulties that can lead to erroneous conclusions. The complexity of a real options approach can also be a critical barrier to its use as a solution. These practical difficulties explain the limited use of the Real Options Theory in analyses and strategic planning. Such an approach is presented by Bowman and Moskowitz [39] (p. 776), for example.

According to Patena [40], however, in fact every project can be valued by means of the Real Options Theory, if only it includes the possibility of some flexibility (available for project managers), for example, to abandon the project, postpone its implementation or make changes in the course of the project. In conclusion, almost any company can be regarded as a collection of real options [40] (p. 242). The inclusion of a new framework for the valuation of start-up companies may introduce optimism resulting from entrepreneurship and include flexibility in the process of estimating and managing value. A key area of option valuation is understanding their meaning, especially when dealing with innovative start-up companies, where it is essential to consider the nature of research and development that will be included in the company activities, required in the first years of company operation. The flexibility of this method is crucial here as the discounted cash flow approach to a start-up's evaluation is usually not sufficient [41] (p. 20).

In this approach, the business model will be an important point of reference and the object which is subject to change depending on proposed real options. Further business model components can be seen as optional and that can be exchanged for others or got rid of altogether. Like financial options, all such phenomena can be called real options. If the investment opportunities include real possibilities, it is important to take into account their value. Therefore, in determining the financial viability of a business model that has real potential, it is necessary to

take into account the value of these options. According to Kundish and John, rather than developing theoretical details of the valuation, it is possible to show how the optionality can be integrated with a business model of representation (BMR) and how the considered options may have an impact on the financial condition estimated for a specific business model [42] (p. 4456). As regards the relationship between real options and corporate strategies, interesting results have been presented by Wiśniewski and Pawlak [43]. In addition to the favourable conditions for the use of real options in corporate strategies, the attitude of executives and the implemented vision of the future are important for their suitability. If the company wants to decide about the future of the sector, when it should take into account the uncertain future factors and the behaviour of competitors, real options become a natural tool to support decision-making. Strategies of market-leading companies are usually capital-consuming, and they tend to be based on innovative, highly risky solutions. It is particularly important to notice alternative scenarios for developing and designing possible reactions to their occurrence [43] (p. 583). It is also possible to combine the philosophy of real options with the method of measuring and monitoring achievements, for example, by means of a balanced scorecard. Final decisions should be made by managers on the basis of specific compromises, which are relevant to the current economic conditions [44] (pp. 53–58). For each options scenario, a dedicated strategy map can be prepared that actually reflects the dynamic decision-making while maintaining the flexibility of strategic change.

As Obłój shows in relation to the application of Real Options Theory in strategic management:

1. Under conditions of extreme uncertainty, rational strategies in the form of a set of realistic options can be built.
2. Different types of real options will have different value for different companies, depending on their specific context, as well as their resources, skills and history.
3. Thinking about strategy in terms of real options sequences helps to assess the correctness of the direction and volume of strategic investments better than traditional budgeting tools [45] (pp. 175–181).

Also, real options take better into account that:

- probabilities and forecasts change their value over time;
- the changeability of the situation can rapidly affect the value of the undertaking and the value of options—both negatively and positively;
- it is not enough to create value in the market, but it is still necessary to build the mechanism of its appropriation, and its effectiveness is not obvious at the moment of strategic undertakings; and that
- there may be many decision-making moments, and a company's pace of learning and its resources change the chances of success [45] (pp. 194–195).

Krychowski [46] highlights the issue of using real options in designing business models, stressing the high degree of business model uncertainty. An innovator does not know from the beginning what the effect of a proposed business model will be. Therefore, it is reasonable to use real options. The main benefit of real options compared to conventional tools for strategic investment valuation such as NPV (Net Present Value) and other DCF-based methods is the possibility of assessing which investment projects may be better suited and more flexible regarding the economic situation. Real options make it possible to combine strategic plans and financial analysis. Also, they help to understand why some large projects are undertaken for strategic reasons, despite a negative NPV and vice versa [46] (p. 6). This reasoning can be applied to the context of the design and development of business models, especially for start-ups, whose development scenarios can dynamically change due to uncertain boundary assumptions and difficult-to-predict future cash flows. Then, particular problems arise in assessing their value. The logic of the real options method is based on the assumption that future investment and development opportunities depend on previous investment decisions. A company's development is seen as a sequence of decisions. Emphasizing the sequencing and possibility of introducing successive adjustments in the process of capital budgeting (or more broadly, in the process of company development) as opposed to analysing certain decisions as "now or never" solutions is—according to proponents of this method—the essence of the difference between using real options and DCF and other methods based on discounting the expected cash flows [47] (p. 189).

The use of real options allows for the transformation of innovative ideas into profitable ventures in entrepreneurial processes. The appearance of options for the company will, in particular, build new and strategic competence so that the options could be used [48] (p. 387).

Although Real Options Theory derives from the theory of finance, it is in some ways very similar to the assumptions of the lean start-up concept. One similarity lies in the decision-making flexibility, which contributes to learning opportunities in subsequent stages of the investment process. If the investment in the business model is treated as a project that never ends, pivot management as part of the lean start-up approach will incorporate Real Options Theory, which so far has not been part of operational management but of the analytical process used in the process of company valuation or other decision-making situations. The flexibility of the business model achieved using the assumptions of Real Options Theory and the lean start-up concept increases the investment attractiveness of start-ups.

5. Conceptualizing Sustainable Business Models for Start-Ups

The dynamic testing of strategic hypotheses as an attribute of the lean start-up concept relates in particular to verifying business models. Making changes in

the business model configuration vis-à-vis the base model, on which the decision to invest in a business venture relies, is recommended in this approach. This is accomplished by making strategic pivots that navigate the business model towards achieving the ability to capture value from the market. In the process of designing the business model, the best idea is, in the earliest stages of the process, to think in terms of opportunities to make future modifications and also, if it is justified, to reconstruct the business model at later stages, if the project does not meet expected goals. Incorporating the maximum number of real options into the business model is favourable to making effective turns towards providing the expected return on investment.

Flexibility is a factor that plays a stabilizing function for business models in the early stages of development. The purpose of a start-up is first and foremost to survive and ultimately achieve market success. Skilfully making dynamic changes in the business model contributes to achieving business goals in a process of adjusting the business model regarding its ability to create value for shareholders. The sustainability of a start-up business is reflected in a set of business model components that make up a consistent configuration of a maximum number of potential real options that enable quick strategic turns when the business model does not capture value from the market in a given situation. A sustainable business model considered at the early stages of a company's development should be based on the search for such a combination of factors to boost and stabilize business operations, which provides scalability, flexibility and agility with a positive attitude towards business stakeholders. Balance is the key axis around which revolves business activity of the company. Flexibility and agility should be the result of a large number of possible strategic options for the use of a dynamic development of the company. Sustainability should be based on managing a dynamic dialogue with the different groups of stakeholders (investors, employees, customers, business partners, and others) and, simultaneously, strengthening their strategic support regarding the enterprise's development directions. The number of strategic options increases the flexibility and agility of the company, and, therefore, its ability to survive. Hence, in this case, the sustainable business model is understood, on the one hand, as the ability to balance the goals of various groups of stakeholders, and on the other hand, as the ability of companies to survive in very difficult market conditions in the initial phase. Incorporating additional real options that, in the future, can be implemented into the business model increases company value and favours the rapid reconstruction of the base model. This state increases the investment attractiveness of the company, whose primary attribute is the flexibility of its business model thanks to the options provided by its configuration. Based on the literature and my own findings, I propose the following definition of a sustainable business model for a start-up: It is a set of characteristics determining a business model, based

on the joint implementation of the assumptions of Real Options Theory, flexible testing of potential hypotheses and a dialogue with stakeholders that will ensure the survival of a start-up and help it to turn into a successful company. According to this interpretation, a sustainable business model helps the company to survive and increases its investment attractiveness as it makes the decision-making process easier and reduces business risk (Figure 2).

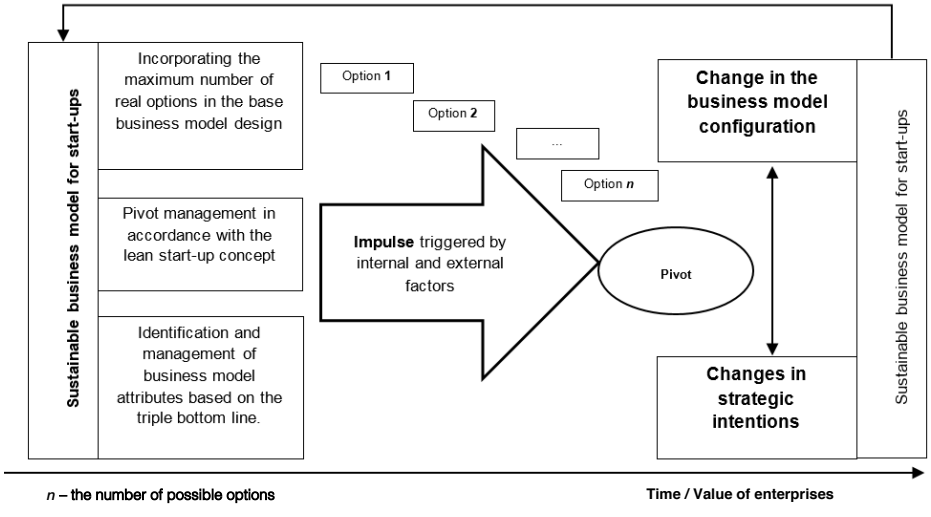

Figure 2. The rationale for developing assumptions of a sustainable business model for startups.

While business is conducted, circumstances may occur that force managers to make changes in the configuration of business models. Also, the value of the company may change. In order to develop the features of a sustainable business model, a company should try to incorporate the maximum number of real options into its configuration at the stage of designing its business model. In the case of an impulse caused by internal and external factors, start-up managers should quickly reconstruct the business model configuration and make changes in the strategic intentions, taking advantage of the opportunities that are inherent in the potential options. Therefore, a sustainable business model is a model that reduces the risk of failure and enables the company to make changes quickly in order to achieve business goals, even if the initial assumptions have become significantly obsolete. A business model can be stabilized by applying the principles of the triple bottom line, maintaining an active dialogue with stakeholders and applying the principles of corporate governance in relation to the tasks of information policy towards stakeholders, especially investors.

6. Research Methodology

Research was based on the principles of qualitative research supported by bibliographic research. The qualitative research used the proposal by Creswell [49]:

- Decide if theory is to be used in the qualitative proposal.
- If it is to be used, then identify how theory will be used in the study, such as an end point, or as a transformative advocacy lens.
- Locate theory in the proposal early in the study or at the end.

The purpose of research was to identify the characteristics of young companies that clearly focus on survival. Research was based on a sample of four selected companies, which are listed on the NewConnect AIM in Warsaw and operate in the renewable energy sector and was conducted in 2015–2016. Due to uncertainty in terms of the stabilization of legal requirements in Poland, this sector generates high risk for adequate business model design. These companies were able to survive in these difficult conditions, and even move to the stage of development and growth. The scope of research included:

(a) Review of the literature on business models, start-ups, Real Options Theory and the assumptions of the lean start-up concept as an approach to the survival strategy of young companies.
(b) Analysis of the business models of companies in the early stage of development in terms of survival strategy implementation and development based on information documents and periodic reports.
(c) Identification of qualitative factors that determine the chances of survival of young companies in the context of their incorporation into the business model structure, shaping a sustainable business model.
(d) Determining a configuration of tools for managing companies in the early stage of development that is applicable to the attributes of the business model, enhancing survival ability.

It should be noted that two key assumptions have been adopted in this paper:

1. A sustainable start-up is an agile and flexible company that can incorporate strategic options into its business model for use when needed. This is a company that monitors its business model by formulating strategic hypotheses and verifying effectiveness and efficiency of the business model.
2. A sustainable start-up is a company that applies the principles of the triple bottom line (i.e., that balances the economic, environmental and social objectives) at the earliest possible stage of development, maintaining a dialogue with different groups of stakeholders.

Research aimed to prove whether the dynamic adaptation of the business model to the changeability of the environment and to the balance of economic, environmental and social objectives can be favourable to the survival of a company in the early stage of development. With reference to the research problem, two research hypotheses have been formulated:

Hypothesis 1. *A condition for the survival of the company in the early stages of development is to incorporate the maximum number of real options into the business model and thus its ability to dynamically change by testing its strategic hypotheses.*

Hypothesis 2. *A necessary condition for the survival of the company in the early stages of development is to use the assumptions of the triple bottom line concept in such a way that they are applied as early as possible in the life cycle of the company.*

In this way, it is possible to shape the assumptions of a sustainable business model of companies in the early stage of development based on the attributes characterizing the ability of a business model to change dynamically and a strategy of balancing the goals of different groups of stakeholders.

Table 2 shows the selected companies listed on the NewConnect market operating in the renewable energy sector, whose business models are based on the ability to change and place emphasis on applying the principles of the triple bottom line. The presented companies were forced to seek and implement various strategic options due to high uncertainty resulting from the instability of legislation in the field of renewable energy sources.

Table 2. Selected companies listed on the NewConnect Alternative Investment Market (AIM).

No.	Type of Renewable Energy	Companies Listed on the New Connect AIM in Warsaw
1	Photovoltaic systems	Sunex S.A.
2	Hydropower plants	MVA Green Energy S.A., Automatyka Pomiary Sterowanie S.A., Genesis Energy S.A.
3	Biomass co-firing	Fluid S.A.
4	Biogas	BGE S.A., Esperotia Energy Investment S.A.

Qualitative research based on information documents and periodic reports covered the parameters that were considered to be the determinants of business

model sustainability of companies in the early stages of development. These parameters were divided into two categories: parameters that make a business model more dynamic and parameters that stabilize a business model. Both groups of these parameters are responsible for ensuring the sustainability of the business model.

Parameters that make a business model more dynamic include:

1. The number of strategic options in the business model that can actually be implemented.
2. Strategic scenarios presented in development strategies, which are the basis for testing strategic hypotheses.
3. The ability to change the configuration of the business model and the direction of the company's development.

Parameters that stabilize a business model include:

1. The incorporation of the principles of the triple bottom line (economic, social and environmental factors) into the business model.
2. The identification of stakeholders' needs.
3. The identification of the principles of corporate governance that are appropriate for companies in the early stages of development.

These three factors that make a business model more dynamic and three that stabilize a business model determine the assumption of the proposed concept of ensuring company sustainability in the early stages of development. While the dynamic factors stem from the theoretical assumptions of Real Options Theory, the lean start-up concept, and a configuration approach to business models, the stabilizing factors derive from the triple bottom line concept and the concepts of stakeholder involvement and corporate governance.

The research findings are shown in Table 3. Research relates to the joint consideration of factors arising from the dynamics of the company operation in terms of a flexible business model—based on using alternative strategic options; testing strategic hypotheses related to changing strategic scenarios according to the lean start-up concept; and the principles of the triple bottom line—corporate governance principles adequate for the NewConnect alternative market and dialogue with stakeholders.

Table 3. Findings of research on selected companies on the NewConnect AIM.

Parameters That Make a Business Model More Dynamic	Company 1 (Biogas Plants)	Company 2 (Agricultural Biogas Plants)	Company 3 (BIOMASS co-Firing)	Company 4 (Photovoltaic Systems)
The number of strategic options incorporated into the business model possible to implement.	Two strategic options: 1. Expanding the scale of operations by implementing further biogas projects, both under own aegis and under the aegis of energy partners. 2. In the case of own biogas plants, sell electricity.	Four strategic options: 1. Expanding the scale of operation in the production of electricity and thermal energy. 2. Diversifying the conducted activity as a substitute investor for various entities and a broker in selling electricity to own project companies. 3. The expansion of activities outside the home country. 4. Biomass sales.	Two strategic options: 1. Expanding the scale of the production by producing biochar. 2. Scientific research.	Three strategic options: 1. Expanding the scale of operation outside the home country. 2. Product diversification—selling and assembling solar systems. 3. Option of entering into cooperation with other companies.
Strategic scenarios presented in the development strategies which are the basis for testing strategic hypotheses.	One scenario based on the strategy of expanding the scale of operations.	Two scenarios based on expanding the scale of operation and testing strategic hypotheses in the field of product diversification.	Two scenarios based on expanding the scale of operation and testing strategic hypotheses in the field of product diversification.	Three strategic scenarios for which strategic hypotheses are tested in the field of foreign operation, product diversification and cooperation with other companies in the form of alliances, mergers and acquisitions.
The ability to change the configuration of the business model and the direction of the company's development.	The ability to change a business model due to the availability of resources, and appropriate technology.	The ability to change a business model based on high-quality competencies of managers and relational capital.	The ability to change the configuration of the business model in the context of the changing regulations in the sector of renewable energy sources, resulting, inter alia, from the need to adjust domestic regulations to the standards of European Union law.	The ability to change a business model based on high-quality competencies of managers and relational capital, as well as flexibility in product sales.

Table 3. *Cont.*

Parameters That Stabilize a Business Model	Company 1 (Biogas Plants)	Company 2 (Agricultural Biogas Plants)	Company 3 (BIOMASS co-Firing)	Company 4 (Photovoltaic Systems)
Incorporating the assumptions of the triple bottom line (economic, social and environmental factors) into the business model.	1. Strong commitment to meeting the requirements of the law in the field of environmental protection. 2. Strong commitment to creating value for shareholders. 3. Strong commitment to respecting workers' rights.	1. Strong commitment to meeting the requirements of the law in the field of environmental protection and energy law. 2. Strong commitment to creating value for shareholders and other stakeholders, in particular the partners in the network of companies linked by capital. 3. Strong commitment to respecting workers' rights.	Strong commitment to meeting the requirements of the law in the field of environmental protection and energy law.	Strong commitment to meeting the requirements of the law in the field of environmental protection and energy law.
Identifying the needs of stakeholders.	Commitment to analyzing the needs of stakeholders and respecting their needs.	Strong commitment to analyzing the needs of stakeholders and respecting their needs.	Strong commitment to analyzing the needs of stakeholders and respecting their needs.	Strong commitment to maintaining a dialogue and analyzing the needs of stakeholders as well as respecting their needs.
Identifying the principles of corporate governance appropriate for companies in the early stage of development.	Commitment to pursuing the objectives of the information policy arising from the regulations of the New Connect Alternative Market.	Commitment to pursuing the objectives of the information policy arising from the regulations of the New Connect Alternative Market.	Commitment to pursuing the objectives of the information policy arising from the regulations of the New Connect Alternative Market.	Commitment to pursuing the objectives of the information policy arising from the regulations of the New Connect Alternative Market.

The findings indicate that companies from the sector of renewable energy sources, in order to survive, use different approaches to make their activity flexible, due to very high changeability and uncertainty resulting from the unstable law in the field of renewable energy sources. By using strategic options incorporated into the business model; by balancing the goals of different groups of stakeholders; by applying the principles of corporate governance based on the capital market regulations; and by meeting the economic, environmental and social objectives, they retain the ability to survive and even develop. At the same time, they test strategic hypotheses based on potential changes in both the business model and development strategies. They take notice of the parameters that make more dynamic and stabilize a business model, respectively, thus developing their ability to survive. Not only did the studied companies survive in the unfavourable legal environment in the field of renewable energy sources but they also increased their market capitalization, owing to the strategy of implementing necessary changes.

7. Conclusions

At the level of conceptualization, the parameters that make more dynamic and stabilize a business model, respectively, are the starting point for shaping the determinants of start-up survival. These assumptions should be incorporated into the structure of a sustainable business model. At the level of operationalization with the combined use of Real Options Theory and the lean start-up concept, it is reasonable to use the proposed solutions. The literature review and my own research allow the following conclusions:

1. The dynamics of the business model, and the balance and stability of the relationship with the environment create better survival conditions for companies in the early stages of development.
2. Instability and uncertainty determine the need to make business models flexible, using different methods.
3. The sustainability of a start-up is a key factor characterizing a sustainable business model.
4. Components shaping business models can be modified, using strategic options incorporated into the business model.
5. Dynamic testing of various hypotheses about the business model efficiency is favourable to the sustainability of companies in the early stages of development.
6. Using a decision tree to design business models can be an important element of business analytics, supporting the process of monitoring the company's ability to survive.
7. Companies realize that the flexibility of the business model, supported by management tools, determines the survival of a young business venture.

8. A sustainable business model of start-ups should be based not so much on the principles of sustainable development but in particular, it should be characterized by the dynamic ability to adapt to the internal and external environment.

The findings of qualitative research have proven that companies whose business models were designed to take into consideration potential additional real options and who tested them in order to make the business model as effective as planned, not only survived but also achieved the expected growth and development. If, at the same time, they took into account the principles of the triple bottom line, they developed the ability to maintain a dialogue with stakeholders. As a result, they were able to detect the stakeholders' needs, which allowed for another value driver to determine the survival of the company.

It was important for the studied companies to test strategic hypotheses dynamically, which supported changes in designed and implemented business models. Due to delays in implementing the legislations related to renewable energy sources in Poland, some of the studied companies had to modify their business models in order to survive and achieve their development goals. Predicting various real options in the business models enabled the companies to make changes and adapt to the changing external and internal environment effectively.

It should be noted that research limitations include the number of studied companies and the scope of their activity. There was a small number of companies listed on the NewConnect AIM in Warsaw pursuing a strategy of the triple bottom line, and operating in the renewable energy sector. Such companies were the focus of this research due to their difficulties in implementing legal regulations regarding renewable energy sources, which was for a long time a large uncertainty affecting the development and business model strategies of companies operating in this sector. Accordingly, the business models of the selected companies had to conform to the principles of economic performance (requirements of shareholders in relation to activities in the capital market), environmental effectiveness (compliance with environmental regulations and results from the scope of activity in the sector of renewable energy sources), and social requirements (maintaining a social dialogue regarding environment-related investment).

A sustainable business model of companies in their early stages of development should be based on the abilities to quickly make changes in the business model due to the fact that a large number of alternative options are incorporated into its construction, which can be implemented in a given situation. This approach should be supported by the assumptions of the lean start-up concept, which is based on strategic pivot management. If possible, a sustainable business model for start-ups should use, like the large companies do, the triple bottom line assumptions, which may increase the investment attractiveness of these companies due to potentially

fewer risks related to, for example, the dissatisfaction of various stakeholder groups. By finding the two research hypotheses confirmed, the presented approach extends previous research on the concept of a sustainable business model by drawing attention to start-up companies.

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Assessing the Impacts of Labor Force Sustainability in Terms of Population Ageing on the Economic Sustainability

Zhichao Sun, Yu Song and Ivan K.W. Lai

Abstract: The age structure of a population will affect the labor force sustainability, which ultimately affects the economic sustainability of a country. This study aims to develop a model for assessing the labor force sustainability in terms of population ageing and its impacts on economic sustainability in different industries and the national economy. This model is based on a computable general equilibrium (CGE) mechanism that consists of three components: (1) forecast of labor supply; (2) forecast of labor demand; and (3) assessment of the impacts of labor market imbalance (shortage) on the macroeconomy. The results of the economic forecast of China prove that this model can effectively assess the impacts of labor market imbalance on economically sustainable development. Furthermore, a simulation forecast of China from 2014 to 2030 was performed. The results show that the contributions of most of China's industries to the gross domestic product (GDP) show a negative growth trend. From the medium- and long-term points of view, the influence of population ageing to the labor-intensive industries is the most serious. The construction industry's contribution to GDP growth rate still shows a rising trend, but the growth rate decreases annually. The service industry's contribution to GDP growth rate shows a significant upward trend, but the rate is decreasing annually. Economic growth shows a declining trend. Population ageing has little influence on consumption and investment, but in absolute numbers, the GDPs growth rate is lower in scenarios that consider population ageing than in scenarios that do not. The pulling effect of exports to economic growth will continue to decrease.

Keywords: population ageing; labor supply and demand; labor market imbalance; the macroeconomy; CGE model

1. Introduction

The ageing of the population has caused concerns related to its effects on the labor markets of many countries [1]. The labor market can serve as an effective mechanism for contributing to economic growth and for transmitting the gains from economic growth [2]. In many developing countries, the economic rise depends

on the supply of a large, cheap, and productive labor force. However, in the era of global ageing, the growth of the economy and the population ageing in developing countries are both accelerating. Meanwhile, the ageing of the population may affect the economy as productivity hardly increases due to labor shortage. This is the labor force sustainability problem [3].

In 1979, the Chinese government implemented the "One Child per Couple" policy aimed at slowing population growth [4]. The total fertility rate declined from 2.8 children per woman in 1979 to 1.7 in 2013 [5]. The age structure of the population has changed quickly in a developing country with a per capita gross domestic product (GDP) of USD 7485 in 2014. Chinese cities have begun to experience some shortages in unskilled labor [6]. Now, China is facing a new challenge of an ageing population, which could affect its labor force sustainability, and, ultimately, economic sustainability [7]. Economic sustainability is the ability of an economy to support a defined level of economic production indefinitely. Although there are some studies on the relationship of an ageing population and economic development in China, they mostly focus on the economic impact of population ageing on economic growth. There is a lack of studies on the effects of labor force imbalance (shortage) on the macroeconomic development.

The aim of this study is to develop a model for assessing the labor force sustainability regarding the ageing population and its impacts on economic sustainability in different industries and the national economy. Computable General Equilibrium (CGE) models are widely used for measuring the impacts of policy interference on sustainability issues [8]. In this study, the impacts of labor force sustainability (as a result of "One Child per Couple" policy) on economic sustainability will be assessed using a CGE model that consists of three components: (1) forecast of labor supply; (2) forecast of labor demand; and (3) assessment of the impacts of labor market imbalance (shortage) on the macroeconomy. This model will be validated using the data of previous Chinese economy outputs (1987–2005) to forecast the economic changes in following years (2006–2013). Furthermore, a simulation forecast (2014–2030) will also be performed to predict the economic situation based on current population ageing. Some macroeconomic policies regarding population ageing will be recommended in order to achieve sustainable economic growth in the future.

2. Literature Review

2.1. Studies on Population ageing and Its Impact to Economy

In 1994, the World Bank published its first report on the crisis of population ageing to determine the effects of reallocation of income, saving and insurance in national finance security systems. It recommended governments to employ

a multi-pillar pension system to solve the financial crisis caused by population ageing [9]. In 1996, the World Bank published two more reports on Chinese population ageing problem. One report discussed problems of the Chinese Pay-As-You-Go (PAYG) pension system in the short run and long run and simulated several policies to solve the problem. The conclusion is that China's pension system must be combined with competition, diversification, and effective rules [10]. The other report estimated the speed and range of China's population ageing, and the cost of supporting the elderly. It suggested that China should establish a transparent, decentralized pension system with an occupational fund or individual savings account to improve the quality of old people's lives [11].

Many scholars studied the effects of population ageing on productive and economic growth. Beginning as early as 1989, when Auerbach and Kotlikoff [12] from the United States used a general equilibrium model with an Overlapping Generation Model (OLG) algorithm to study the economic dynamics of Germany, Japan, Sweden, and the USA. They found that the national savings rate, real wages, and savings are impacted the most. Williamson [13] first raised the concept of the "demographic gift" in studying East Asia's economies, referring to a relatively small proportion of teenagers and elderly but a relatively large proportion of the working-age population in the demographic structure. He believed that the large proportion of the working-age population in East Asia is helpful in promoting economic growth. Bloom, Canning, and Sevilla [14] used demographic dividends, representing the expanding gap of fertility and mortality, in underdeveloped countries that could offer sufficient labor. They believed that 1/4 of the East Asian economic miracle could be explained by the demographic dividend. Fougere and Merette [15] also found that population ageing would cause the national savings and per capita gross domestic product growth to decrease, but would also bring great pressure to the overall tax burden. Prettner [16] investigated the consequences of population ageing for long-run economic growth perspectives. He found that increases in population longevity have a positive impact on per capita output growth, while decreases in fertility have a negative impact on per capita output growth. The positive longevity effect dominates the negative fertility effect in the case of the endogenous growth framework, and population ageing fosters long-run growth in the endogenous growth framework, while its effect depends on the relative change in fertility and mortality in the semi-endogenous growth framework. Uddid, Islam, and Kabir [17] attempted to assess the demographic support and dividend of the ageing process in Bangladesh and found that future resources for supporting the elderly will be limited to both urban and rural areas if the current trends prevail. The degree of support for the elderly decreased due to the demographic transition. Foroni, Fulanetto, and Lepetit [18] proposed a new value at risk (VAR) identification scheme to disentangle labor supply shocks from wage bargaining shocks. According

to analysis of US data over the period 1985–2014, labor supply shocks caused by population ageing and wage bargaining shocks are important drivers of decreasing output and unemployment, both in the short run and in the long run. They also found that labor supply shocks are the main drivers of the decreasing participation rate and account for about half of its decline in the aftermath of the Great Recession.

In recent years, studies on population ageing expanded from developed Western countries to developing countries. Scholars tend to study population economics from the perspectives of the non-canonical demographics or non-economics, while non-market population biology perspectives have gradually increased, as have studies involving community, political, cultural, human rights, humanitarian, etc. consequences of population ageing.

2.2. Studies on Population Ageing and Its Impact to China's Economy

Since the 1980s, with the implementation of "One Child per Couple" policy in China, the fertility rate dropped significantly, causing the proportion of working-age population to rise. China entered the "demographic gift" period. During this period, a higher proportion of the labor force provided a wealth of labor resources for economic growth. However, the continued low fertility and lower labor force participation rate will end the peak period of labor. According to population prospects from the United Nations [19], China's 15–64 working-age population will decrease after it reaches one billion in 2015. In the coming 20–30 years, the structure of the working-age population will change and the growth rate of the working-age population will gradually slow down [20]. At present, China's new labor force and the increased demand of labor force have been more or less balanced. Even though an absolute shortage of labor in China does not present itself, indications of a structural shortage have emerged. This means that the competitive advantage on the global market of cheap labor will continue to be weakened. Sooner or later, labor shortages will eventually become a reality [21]. China's population will reach a peak in 2023 after which it will decrease rapidly [22]. This demographic trend will lead to the very important issue of labor shortage. This period of abundant labor supply will remain for about 10 years, after which its size will gradually reduce. From an international point of view, after the transition of a country's population structure and the ageing of the working-age population, it will soon face labor shortages [23]. Yang and Luo [24] made an empirical study on the dynamic relationships of population ageing, technological innovation and economic growth using a panel data VAR model based on Chinese provincial panel data from 1999 to 2013. The results showed that in the short term, population ageing in China is bound to adversely affect economic growth, while in the long term, the influence of population ageing on economic growth lies in the comparison of its positive and negative effects. They also found that at present, population ageing did not

significantly influence technological innovation. Hu and Xu [25] investigated how population ageing would affect the savings rate. Based on the optimal behavior of a household, they found that population ageing would affect the savings rate, showing different effects for urban households and rural households. With the Chinese Household Income Project (CHIP) data, they constructed pseudo-panel data and verified that the savings rate of an urban household was increased with population ageing, while that of a rural household was decreased with population ageing. Based on this result, they forecast that the savings rate in China would not decrease with population ageing. Wang and Tong [26] found that with population ageing, China's labor force participation rate has shown a declining trend in recent years. They used econometric methods to study how much population ageing affects the labor participation rate, and found that the ageing of the population, especially the ageing of the working-age population, has a negative impact on the labor force participation rate.

Compared to foreign research in this field, China started very late. Early scholars addressed more the age structure of population ageing, and cared more about supporting the elderly. Most of them discussed the economic consequences caused by population ageing, or made descriptions based on macroeconomic survey data from the perspective of demography, while lacking any theoretical basis of comparative dynamics.

2.3. The Development of Computable General Equilibrium (CGE) Model

French economist Léon Walras was the first to propose the general equilibrium (GE) concept in the Elements of Pure Economics in 1874. He expressed Adam Smith's "invisible hand" as a set of equations. In the late 1940s and 1950s, Kenneth Arrow, Gerard Debreu and Lionel McKinsey, respectively, proved the existence and validity of general equilibrium with their theories and methods, and laid the foundation of modern general equilibrium theory. After the 1950s, with the development of computer technology and data availability, GE theory was developed using computers to make the calculations. In 1960, Leif Johansen built the world's first CGE model, a multi-sectorial growth model [27]. Until the 1980s, CGE models have been developed very standardly and actively as a branch of economics.

CGE models are a digital set and description of the entire economic system. Various economic entities within the economic system are involved in balancing it, by adjusting the quantities of goods and factors as well as prices, and this process is the Walras GE between supply and demand. In simple terms, the purpose of the establishment of CGE models is to turn an abstract form into a mathematical model close to the real economy. CGE models can simulate the entire economic system. It was initially an academic research tool but has rapidly grown into an

actual policy analysis tool for trade policy, tax policy, environmental policy, energy policy analysis, etc.

Fougere and Merette [15] integrated the cross-level iterative models using the CGE model and estimated the population ageing's impact on the economy. In recent years, scholars from China have also adopted CGE model to study the ageing population's impact on the economy, especially in the pension system. Bai and Xi [28] used the comparative static method in CGE to evaluate the overall impact of pension reform on the economic system with the indexes of GNP, unemployment, sectoral output, government deficit, investment in fixed assets as indicators, proposing appropriate countermeasures. They also studied the impacts of various reform options on the sustainability of the pension system and economic growth. Peng [29], using a CGE model and a given ageing profile of the population to forecast the growth path of China's economy during the 21st century, found that population ageing leads to declining economic growth as labor supply shrinks and the physical capital formation rate declines. The main force that can sustain China's economic growth against the backdrop of population ageing is productivity improvement.

3. Labor Force Sustainability Models

3.1. Forecast of Labor Supply

In this study, the population model is employed for forecasting the working-age population because its result is of high reliability. Here, the maximum life expectation is assumed to be 100. The population of age j in year t is predicted as:

$$P_j^t = P_{j-1}^{t-1}\left(1 - d_{j-1}\right),\ 100 \geq j \geq 0 \tag{1}$$

P_j^t is the population of age j in year t and d_j is the natural population mortality of age j.

The total number of babies born in year t is calculated using the entire 15–49-year-old female population $\sum_{i=15}^{49} P_i^{t-1}$ multiplied by its corresponding fertility S_i.

$$P_0^t = \sum_{i=15}^{49} P_i^{t-1} * S_i \tag{2}$$

where S_i is the fertility of i-year-old females.

The labor supply is assumed to be the 15–64 age group. The size of the labor supply is the population of 15–64 year olds minus students in the school-age group, domestic workers, and those who are unable to work. In order to have a figure closer

to the actual situation, the concept of labor force participation rate recommended by Wang [30] is employed for calculating the labor supply. The labor supply in year t is:

$$L_s^t = \sum_{i=15}^{64} P_i^t * LFPR_i \tag{3}$$

where L_S^t Is the labor supply in year t and $LFPR_i$ is the labor force participation rate of i-year-old population. The forecast of labor supply is shown in Table A1.

3.2. Forecast of Labor Demand

In this study, the econometric model and the employment elasticity law are used to predict the labor demand [22]. For the economic model, because the number of employees of the current year and the number of employees of the previous year are closely linked, the establishment of self-regression model is built to predict the demand for labor.

$$L_t = a + bL_{t-1} + u_t \tag{4}$$

L_t represents the number of employees in year t, a is a constant number, and u_t is the random error.

The following describes the measurement of employment elasticity, where β_l represents employment elasticity value, Y represents economic output GDP, and L represents the employed labor force. Defined by the employment elasticity:

$$\beta_l = \frac{\frac{\Delta L}{L}}{\frac{\Delta Y}{Y}} \tag{5}$$

In Equations (1)–(5), the employment elasticity = employment growth/economic growth, so employment growth rate = employment elasticity × economic growth. Next are the employment elasticity β_l measurements. Double logarithmic model (logarithmic current model) can be used, and the employment in year t is L_t, and the gross domestic product is Y_t.

$$\ln L_t = \beta_0 + \beta_l \ln Y_t + \varepsilon_t \tag{6}$$

where ε_t is corresponding random error item. The resulting β_l from Equation (6) calculated with data is employment elasticity. In actual measurement, in order to be more accurate, employment elasticity can be carried out by industry, resulting in weighted average employment elasticity. The forecast of labor demand is shown in Table A2. It is quite clear that labor demand exceeds labor supply starting in 2015 (Tables A1 and A2).

3.3. Construction of a Static Model

A computable general equilibrium model is a powerful tool for policy analysis. Dervis et al. [31] constructed a CGE framework of an open economy. Lofgren et al. [32] of International Food Policy Research Institute (IFPRI) used General Algebraic Modeling System (GAMS) to realize this theoretical framework and develop the IFPRI model. IFPRI model is a standard model. It provides a flexible framework for static CGE analysis and complete GAM program code. It explains economy structure well and reduces the difficulty of secondary development: firstly, the production activities, commodities, and households accounts can be subdivided; secondly, it can remove unnecessary set up to simplify the model; and, thirdly, the standard model is very flexible for macro closure and factor markets closure set. More importantly, model and data are separated in this framework, which means the research of SAM data and model equations are strictly separated. The static model in this paper is constructed based on IFPRI model, and its dynamic expansion is referred from the work by Thurlow [33] and Diao et al. [34].

In this study, two Social Accounting Matrixes (SAMs) are prepared. The first matrix is a macro SAM (Table 1), which covers the production and consumption sectors. The second matrix is a micro SAM of each industry (data not shown). A GAMS program is used to solve the CGE model.

The data were acquired from the "China Statistical Yearbook" from 1987 to 2007 by the National Bureau of Statistics, and the method of processing data comes from Robinson et al. [35].

Table 1. Macro Social Accounting Matrixes (100 million).

	Activities	Commodities	Factors	Households	Enterprises	Government	Savings-Investment	Rest of the World (ROW)	Total
Activities		Marketed outputs 818,859		Home-consumed outputs 96,553					Activity income 818,859
Commodities	Intermediate inputs 552,815	Transaction costs		Private consumption		Government consumption 35,191	Investment 114,212	Exports 95,541	Demand 894,312
Factors	Value-added 227,525							Factor income from ROW	Factor income 227,525
Households			Factors incomes to households	Inter-household transfers	Surplus to households 41,457	Transfers to households 5447		Transfers to household from ROW	Households income 156,952
Enterprises			Factor income to enterprises			Transfers to enterprises 4834		Transfers to enterprise from ROW	Enterprise income 122,312
Government	Producer taxes, value-added taxes 38,519	Sales taxes, tariffs, export taxes 1433	Factor income to government, factor taxes	Transfers to government, direct 3186	Surplus to government, direct enterprise savings 8779			Transfer to government from ROW −5635	Government income 46,281
Savings-Investment				Household savings 57,213	Enterprise savings 72,075	Government savings 809		Foreign savings −15,885	Savings 114,212
Rest of the World		Imports 74,021	Factor income to ROW		Surplus to ROW	Government transfers to ROW			Foreign exchange outflow 74,021
Total	Activities 818,859	Supply expenditures 894,312	Factor expenditures	Household expenditures 156,952	Enterprise expenditures 122,312	Government expenditures 46,281	Investment 114,212	Foreign investment flow 74,021	

3.3.1. Equations of a Static CGE Model

In the model, there are three types of markets: activities, goods, and factors. Factors are divided into capital K and labor L. Activities and commodities include seven items, and are fully consistent with industries in SAM. The economic entities of this model include households h, enterprises ent, government gov, and foreign entity row. Government taxes are divided into production tax, income tax and customs duty, ta_a, $tins_{INSD}$, and tm_c, respectively.

(1) Mathematic description of a production module:

A production module is a two-layer nested production function. The first layer is a constant elasticity of substitution (CES) function with intermediate input $QINT_c$ and value added QVA_a. The second layer is a CES function composed of capital and labor, showing the incomplete substitution between capital and labor.

$$QVA_a = \alpha_a^{va}\left(\delta_a^{va}\cdot QL_a^{-\rho_a^{va}} + (1-\delta_a^{va})\cdot QK_a^{-\rho_a^{va}}\right)^{-1/\rho_a^{va}}, \rho_a^{va} = \frac{1}{\sigma_a^{va}} - 1 \tag{7}$$

$$\frac{WL}{WK} = \frac{\delta_a^{va}}{1-\delta_a^{va}}\cdot\left(\frac{QL_a}{QK_a}\right)^{\rho_a^{va}-1} \tag{8}$$

$$PVA_a \cdot QVA_a = WL\cdot QLD_a + WK\cdot QKD_a \tag{9}$$

in which, the factors inputs include labor input QL_a and capital input QK_a; α, δ, and σ represent scale parameter, share parameter, and elasticity parameter, respectively; and WL and WK represent labor income and capital income, respectively. Equation (7) is the CES production function. Equations (8) and (9) are the first order terms of minimal cost and maximum profit. Total production QA_a has similar mathematical description (Equations (10)–(12)) and intermediate input $QINT_{ca}$ is Leontief composition of each intermediate input, shown as Equation (13).

$$QA_a = \alpha_a^q\left(\delta_a^q\cdot QVA_a^{-\rho_a} + \left(1-\delta_a^q\right)\cdot QINTA_a^{-\rho_a}\right)^{-1/\rho_a}, \rho_a = \frac{1}{\sigma_a} - 1 \tag{10}$$

$$\frac{PVA_a}{PINTA_a} = \frac{\delta_a^q}{1-\delta_a^q}\cdot\left(\frac{QINTA_a}{QVA_a}\right)^{1-\rho_a} \tag{11}$$

$$PA_a\cdot QA_a = PVA_a\cdot QVA_a + PINTA_a\cdot QINTA_a \tag{12}$$

$$QINT_{ca} = ica_{c\ a}\cdot QINTA_a \tag{13}$$

(2) Mathematic description of a trade module:

The intermediate input composed commodity QQ_c uses the Armington Assumption, which is a CES function of domestic made commodity QD_c and imported

commodity QM_c, as shown in Equations (14) and (15). PD_c and PM_c represent domestic made commodity price and imported commodity price, respectively.

$$QQ_c = \alpha_c^q \left(\delta_c^q \cdot QM_c^{-\rho_c^q} + \left(1 - \delta_c^q\right) \cdot QD_c^{-\rho_c^q} \right)^{-1/\rho_c^q}, \rho_c^q = \frac{1}{\delta_c^q} - 1 \tag{14}$$

$$\frac{QM_c}{QD_c} = \left(\frac{PM_c}{PD_c} \cdot \frac{1 - \delta_c^q}{\delta_c^q} \right)^{1/(\rho_c^q + 1)} \tag{15}$$

Each sector needs to decide the proportion between commodity for domestic consumption QD_c and commodity for export QE_c, and the total output is distributed between domestic consumption and export with incomplete conversion elasticity, shown as Equations (16) and (17). PE_c is the export commodity price.

$$QX_c = \alpha_c^t \left(\delta_c^t \cdot QE_c^{\rho_c^t} + \left(1 - \delta_c^t\right) \cdot QD_c^{\rho_c^t} \right)^{1/\rho_c^t}, \rho_c^t = \frac{1}{\sigma_c^t} + 1 \tag{16}$$

$$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PD_c} \cdot \frac{1 - \delta_c^t}{\delta_c^t} \right)^{1/(\rho_c^t - 1)} \tag{17}$$

(3) Mathematic description of an economic behavior module:

$$PQ_c \cdot QH_c = EH_h \cdot shif_{ch} \tag{18}$$

$$EH_h = (1 - tins_h)(1 - mps_h) \cdot YH \tag{19}$$

QH_c is the households consumption; PQ_c is the final composed commodity's price; EH_h is the consumption part of households income YI_h; $tins_h$ is personal income tax rate; and mps_h is marginal propensity to save.

Households' income YI_h is made up of factor income YF_f, and the transfer payments by enterprises and the rest of the world, $tran_{h,ent}$, $tran_{h,\,gov}$, and $tran_{h,\,row}$, respectively, shown as Equations (20) and (21). Households' expenditure is made up of personal income tax and consumption, and $\overline{EXR}$ means the exchange rate is given exogenously, shown as Equation (22).

$$YI_h = \sum_f shif_{h\ f} \cdot YF_f + tran_{h\ ent} + tran_{h\ gov} + tran_{h\ row} \cdot \overline{EXR} \tag{20}$$

$$YF_f = \sum_a WF_f \cdot QF_{f\ a} \tag{21}$$

$$EI_h = tins_h \cdot YI_h + EH_h \tag{22}$$

Enterprises' income and expenditure behaviors are given by Equation (23) and (24). Enterprises' income YI_{ent} is from the capital return YF_K and transfer payment by government $tran_{ent,gov}$; enterprises' expenditure includes enterprises' income rate and transfer payment to households:

$$YI_{ent} = YF_K + tran_{ent\ gov} \tag{23}$$

$$EI_{ent} = tins_{ent} \cdot YI_{ent} + tran_{h\ ent} \tag{24}$$

Equation (25) defines the government's income from households' income taxes, enterprises' income taxes, production tax, duty and transfer from the rest of the world. Equation (26) defines the government expenditure including transfer payment and government consumption $\overline{QG_c}$:

$$\begin{aligned} \mathrm{YG} = & \textstyle\sum_i tins_i \cdot YI_i \\ & + \textstyle\sum_a ta_a \cdot PA_a \cdot QA_a \\ & + \textstyle\sum_c tm_c \cdot pwm_c \cdot QM_c \cdot \overline{EXR} + tran_{gov\ row} \cdot \overline{EXR} \end{aligned} \tag{25}$$

pwm_c is the world price for commodity c.

$$\mathrm{EG} = \sum_c PQ_c \cdot \overline{QG_c} + \sum_{i \in h,ent} tran_{i\ gov} \tag{26}$$

(4) Mathematic description of closure

Macro closure includes the factor market and commodity market clearing, current accounts and government equilibrium, and investment saving equilibrium. The factor market equilibrium is given by Equation (27). Equation (28) describes the commodity clearing. The aggregation of all factor demand is QF_{fa} which equals the factor supply QFS_f. The composed commodity QQ_c is used in $QINT_{c,a}$, households' consumption $QH_{c,h}$, government's consumption $\overline{QG_c}$, and total investment $\overline{QINV_c}$. The current account equilibrium is described by Equation (29), in which pwe_c means the commodity export price.

$$\sum_a QF_{fa} = QFS_f \tag{27}$$

$$QQ_c = \sum_a QINT_{c\ a} + \sum_h QH_{c\ h} + \overline{QG_c} + \overline{QINV_c} \tag{28}$$

$$\sum_c pwm_c \cdot QM_c = \sum_c pwe_c \cdot QE_c + \sum_{i \in h,ent} tran_{i\ row} + FSAV \tag{29}$$

The investment savings equilibrium is shown in Equation (30). The savings made up of personal savings $PSAV_i$, government savings GSAV and foreign savings

FSAV equal total investment. Equation (31) defines personal savings. Equation (32) defines government savings as endogenous.

$$\sum_{i \in h,ent} PSAV_i + GSAV + FSAV \cdot \overline{EXR} = \sum_c PQ_c \cdot \overline{QINV_c} \tag{30}$$

$$PSAV_i = mps_i \cdot (1 - tins_i) \cdot YI_i \tag{31}$$

$$\text{GSAV} = \text{YG} - \text{EG} \tag{32}$$

For a Keynesian closure, Equations (33) and (34) are needed.

$$\sum_a QK_a = \overline{QKS},\ \text{WK} = \overline{WK} \tag{33}$$

$$\sum_a QL_a = \overline{QLS}, \text{WL} = \text{WL} \tag{34}$$

The static CGE model is established.

3.3.2. Elasticities Value Selection

There is another data source in CGE model besides SAM: elastic parameter. Specifically, there are four in this paper: elasticities of substitution about the added value and intermediate input, factor elasticities of substitution, Armington elasticities in the export trade, and constant elasticity of transformation (CET) elasticities. The elasticity values and micro SAM can be used to calibrate the scale parameter and the share parameters, while other parameters such as the tax rate only requires SAM's calibration; SAM and all parameters constitute the database model required. The elasticity parameters in the production and trade activities are listed in Table 2.

Table 2. Elasticities. Trade elasticity and K–L production elasticity of substitution come from Global Trade Analysis Project (GTAP)'s 7 databases [36] and the rest from the model set.

Sectors	Trade Elasticities		Factors Elasticities	
	Armington	CET	VA-INTA	K–L
01	2.91	5.81	0.6	0.5
02	2.51	5.03	0.6	0.2
03	3.52	7.04	0.6	1.26
04	2.80	5.60	0.6	1.26
05	1.90	3.80	0.6	1.40
06	1.90	3.80	0.6	1.68
07	1.90	3.80	0.6	1.68

CET: Constant Elasticity of Transformation; VA-INTA: Factors elasticity of substitution indicates the elasticity of substitution between added value and intermediate inputs; K–L: elasticity of substitution between capital and labor factor.

3.3.3. Verification of the Static Model

Scholars with CGE model experience know that different closure rules have different impacts on the simulation results. Here, the paper tries to test the impact of different closure rules on the economy and determine the selection of closure.

The verification of the static model is set as expanding government consumption by 10% and 20%, and Table 3 is the result of the economic stimulus. With a Keynesian closure, the effect of government consumption to stimulate the economy is significant. The simulation results with a Keynesian closure can be regarded as short-term effects of policy shocks on the economy: to real GDP, increasing government consumption is favorable; and increased government spending is beneficial to employment. By expanding government consumption by 10%, the labor demand growth is 4.32%, which is about 470.2 billion Yuan. According to the total labor demand of 10,942.8 billion Yuan calculated in the base period equilibrium by the model and employment number 769.90 million in China Statistical Yearbook 2007 [37], it can be calculated that the total demand of 470 billion can increase the employment number by 33.26 million. This is good news for the rest of the labor force in China's national conditions.

Table 3. Simulation Results of Expanding Government Consumption by 10% and 20%.

Simulation Scenarios	**Government Consumption Expanding by 10%**			**Government Consumption Expanding by 20%**		
Closure	**Keynesian**	**Johansen**	**Neoclassical**	**Keynesian**	**Johansen**	**Neoclassical**
Real GDP	1.975	0.232	0.346	4.213	0.487	0.656
GDP deflator	−0.089	−0.005	0.011	−0.188	−0.012	0.022
Labor Return	−1.74	—	—	−3.36	—	—
Capital Return	1.395	−0.004	−0.004	2.805	−0.006	−0.006
Labor Demand	4.322	0.649	0.956	8.788	1.256	1.897
Private Savings	1.628	2.85	0.253	3.283	5.741	0.501
Government Savings	−13.35	−21.60	−20.63	−26.33	−43.01	−41.25
Foreign Savings	−1.02	−0.51	−0.22	−1.72	−1.01	−0.42
Private Consumption	2.155	−2.668	0.636	4.325	−5.321	1.242
Government Consumption	10	10	10	20	20	20

With a Keynesian closure, the impact of 10% increase in government consumption is the decline in government savings initially: In the short term, savings and investment cannot adjust, but overall level of savings cannot meet the original level of investment, and private saving adjust endogenously; to increase the corresponding savings, households will increase labor to increase income, thus increasing the labor employment, and labor return rate falls by 1.74%. The decreasing labor real return means that the cost of production is reduced, and the enterprise expands the output scale, which leads to the increase of capital demand, so the capital

increases by 1.395%. The expansion of output finally causes the real GDP to increase by 1.975%. With Johansen and neoclassical closures, government consumption has a crowding out effect on private sector investment and consumption: the initial impact of the increase in government consumption is still a decline in government savings. With a neoclassical set of an economy driven by the savings, due to the assumption that the savings are exogenous, and long-term investment can be changed, it will automatically adjust to the appropriate level in line with the savings, resulting in private sector investment declining to a new balance of savings investment. The government consumption increases output, and private investment has shrunk to reduce the output. Similarly, with a Johansen closure, economy is driven by the investment, investment is assumed exogenous, and the decline in government savings will lead the government to improve the marginal saving rate of non-government organizations to increase private savings and maintain social total savings and investment balance. The private savings are forced to rise, which causes the reduction of private consumption. The consumption rises in the government sector, and declines in the private sector. The crowding effect makes the stimulation effect of expanding the government consumption on real GDP and employment less than that in Keynesian economics. Regarding import and export, the negative effect of decreased private investment or consumption is greater than the positive effects of expanding government consumption. The imports and exports show a downward trend.

This paper continues to investigate the difference between the three classic closures by expanding government investment by 5% in Table 4. As the index values in the neoclassical closure are 0, this item is omitted.

With a Keynesian closure, government investment increased by 5% will lead to reduced government savings. Because capital formation is fixed for a Keynesian closure, the non-governmental organizations savings rate is fixed, so that the original savings cannot meet the investment needs, and private savings adjusts endogenously. Under the situation of incomplete employment, households increase income by increasing labor supply which makes the savings meet the investment needs, so labor demand increases by 7.55%, and labor return falls by 3.28%. The decline in labor return means true enterprise production cost will also be reduced. The enterprises which pursue profit maximization will expand production, which results in an increase in the capital demand, in the fully supplied capital condition, leading to a capital return increase of 2.71%. The expansion of output results in real GDP increased by 3.24%. Due to government investment expenditure increases, government consumption expenditure decreases by 0.72%. The significant GDP improvement makes the government tax revenue increase and decreases the gap of government investment and income, and, finally, the government income grows by 3.22%.

Table 4. Simulation Results of Expanding Government Investment by 5%.

	Base Value	Expanding Government Expenditure by 5%	
		Keynesian	Johansen
Real GDP	263,758.91	3.24	−0.12
Labor Return	1.00	−3.28	—
Capital Return	1.00	2.71	0.01
Labor Demand	108,896.54	7.55	−0.36
Exchange Rate	1.00	0.09	0.01
Export	94,116.73	2.63	0.64
Import	−72,936.82	3.12	0.83
Private Savings	120,036.77	2.75	4.83
Government Savings	16,488.20	15.69	−1.89
Foreign Savings	−26,084.01	0.05	0.02
Private Consumption	98,317.50	2.88	−6.87
Government Consumption	45,375.64	−0.72	−0.01
Government Investment	110,440.95	5.00	5.00
Government Income	61,863.84	3.22	−0.41
Government Expenditure	45,375.64	−0.74	−0.01

With the neoclassical closure, because savings drive the economy, increasing government investment will crowd out a large number of private investments and fully offset the effect of increased government investment to the economy, and all indicators have no changes.

With the Johansen closure, many simulation results show reverse changes because government investment in the closure has great crowding out effect on consumption. The increase in the government investment first leads to a reduction in government savings; because investment is fixed, the government savings reduction will lead the government to improve the non-government organizations' marginal savings rate to meet the investment needs. The marginal savings rate of non-government organizations is forced rise, which leads to a lot of private consumption crowd-out. This negative effect of crowding out on the GDP is bigger than the pulling effect of investment to GDP, and ultimately the real GDP decreases by 0.12%, total demand for labor reduces by 0.36%, and the income of households is significantly reduced. In the case of a Keynesian closure, the stimulation effect of expanding government investment to the economy is the best. With the neoclassical closure, expanding government investment has no effect on the economy. With the Johansen closure, the expanding government's investment has almost a negative effect on the economy, in particular, it will crowd out a large number of private consumption, so there will be a substantial decline in the welfare of households.

After integrating the two kinds of expansionary fiscal policy simulation analysis, it can be found that different macro closures have different simulation results. The reason for this difference lies in policy shock having different mechanisms

under different assumptions. The most important difference of the three closures is the assumption of savings and investment. The Keynesian closure reflects a short-term economic structure. At the same time, savings and investment are rigid and cannot react to shocks. Johansen and neoclassical closure are different, and reflect long-term equilibrium.

Therefore, macroclosure selection is mainly determined by the model constructor's macroeconomic background cognition and path conduction identification of policy simulation. The different policy simulation schemes should try to select the most appropriate closure rule to deal with flexibility. When policy shock produces function within a short period, and the researcher focuses on short-term economic effects, she can give priority to the Keynesian closure, or she can consider other macroclosures.

3.4. Construction of a Dynamic Model

3.4.1. Recursive Extension Based on the Static Model

This paper refers the dynamic extension of IFPRI standard static model by Thurlow [33] and selectively makes a recursive dynamic extension to the static CGE model. The recursive dynamic attributes of most models mainly embody three aspects: capital accumulation, labor growth, and total factor productivity change. In this paper, the dynamic expansion of the static model also follows these three aspects.

For capital accumulation process, according to the classic economic growth theory, the current period of depreciation of capital stock combined with the new investment forms the capital stock of the next phase.

$$QK_{a\ t+1} = (1 - \delta_a) \cdot QK_{a\ t} + QINV_{c\ t} \tag{35}$$

$$QKS_{a\ t+1} = (1 - \delta_a) \cdot QKS_{a\ t} + \sum_c QINV_{c\ t} \tag{36}$$

where QK_{t+1} represents the capital stock during the phase t+1, δ represents the depreciation rate, and $QINV_{c\ t}$ represents the investment in phase t in Equation (36).

For labor supply, this paper uses the forecast labor supply in Table A1.

Young [38] calculated China's Total Factor Productivity (TFP) in 1978–1998. He found that the annual growth rate of TPF is 3% with official GDP growth rate. Wang and Yao [39] found that in 1952–1977 China's TFP annual growth rate is −1.56% while in 1978–1999 China's TFP annual growth rate is 2.8%. Peng [29] found that in 1992–2000, China's TFP annual growth rate is 4.5%. This paper adopts Young's [38] study result and set TPF annual growth rate as 3% to 2030, shown in Equation (37).

$$\alpha^{va}_{a\ t+1} = \alpha^{va}_{a\ t} \cdot (1 + g_a\ ), g_a\ = 3\% \tag{37}$$

The capital depreciation rates of each sector are referred from Xue and Wang [40] as shown in Table 5.

Table 5. Capital depreciation rates of each sector.

Sector	7	Capital Depreciate Rate (%)
01	Agriculture	6.7
02	Coal Mining	10
03	Oil and Gas Exploitation	12
04	Electric Power Production and Supply	5.45
05	Construction	12
06	Other Industries	8
07	Service	8

3.4.2. Verification of the Dynamic Model

This dynamic model established in this study reflects the economic situation in 2007, and so the base run dynamic range is selected as 2007–2015. If the base run dynamic range is extended, there are no real data to be contrasted, thus losing the ability of error checking. However, it should be noted that, from the beginning of 2008, China's economy endured a series of external shocks, such as the world financial crisis. In order to fight the crisis and maintain growth, in November 2008, the central government of China launched an economic stimulus investment plan to stimulate economic development. This four trillion Yuan stimulus package had a significant effect on the macroeconomy. Base run must take these factors into consideration.

The simulation scenario is used as base run foundation, with the actual GDP, and outputs of agriculture, construction and service as the error evaluation indexes. Table 6 gives the test results of the dynamic model.

The variable L refers to labor demand in 2007–2013 for simulating the impact of the population ageing on the economy by CGE model, as labor is not fully employed during these years. The variable K is determined endogenously with Equation (35). The variable α is set to increase at an annual rate of 3%. Because China does not publish statistics on the output of each industry every year, some industries with statistical data are selected to compare with the forecast results. These forecast figures are very close to the actual figures of the output changes of different industries. Therefore, the construction of the dynamic model is basically successful.

Table 6. Test results of the dynamic model (2007–2013).

	2007	2008	2009	2010	2011	2012	2013
				Real Output Value			
Agriculture	48,893	58,002	60,361	69,320	81,304	89,453	96,995
Construction	15,297	18,743	22,399	26,661	31,943	35,491	38,995
Service	111,352	131,340	148,038	173,596	205,205	231,935	262,204
Real GDP	268,000	316,800	345,600	408,900	484,100	534,100	588,000
				Real Ratio			
Agriculture	1	1.18	1.23	1.41	1.66	1.82	1.98
Construction	1	1.22	1.46	1.74	2.08	2.32	2.54
Service	1	1.17	1.28	1.55	1.84	2.08	2.35
Real GDP	1	1.18	1.28	1.52	1.80	1.99	2.19
				Forecast Ratio			
Agriculture	1	1.13	1.23	1.36	1.69	1.82	1.86
Construction	1	1.26	1.51	1.80	1.88	2.28	3.02
Service	1	1.09	1.24	1.41	1.84	2.08	2.25
Real GDP	1	1.14	1.28	1.45	1.67	1.86	2.06
Average Error	—	−0.03	0.025	−0.05	−0.075	−0.0425	0.0325

3.5. Simulation with the Dynamic CGE Model

3.5.1. The Influence of Population Ageing to Industries

Along with the deepening of the population ageing and urbanization acceleration, declining labor supply has a great impact for many industries; at the same time, changes in the age structure of the population change the corresponding household consumption, savings and investment structure, thereby affecting economic growth. In Table 7, the annual growth rate of seven industries' contribution rate to GDP shows the influences of population ageing. (1) The contributions of most industries to GDP show a negative growth trend. (2) From the long-term point of view, the influence of population ageing on labor-intensive industries is the most serious. (3) The construction industry's contribution to GDP growth rate still shows a rising trend, but the growth rate decreases annually. (4) The service industry's contribution to GDP growth rate shows a more significant upward trend, but the rate is decreasing annually.

Table 7. Annual Growth Rates of Each Industry's Contribution Rate to Gross Domestic Product (GDP) (%).

Industry	2010–2015	2015–2020	2020–2025	2025–2030
Agriculture	5.07	1.68	0.46	−0.42
Coal Mining	−1.72	0.46	1.51	2.27
Oil and Gas Exploitation	−4.14	−4.47	−4.50	−4.76
Electric Power Production and Supply	−4.02	−2.21	−3.51	−2.36
Construction	5.72	2.61	1.09	0.19
Other Industries	−4.08	−3.28	−2.43	−2.03
Service	2.42	1.46	1.02	0.83

These phenomena can be understood as follows: (1) due to the decline of labor supply, the international competitiveness of China's labor-intensive industries declines, so that these industries reduce the pulling of the GDP; (2) population ageing acceleration will reduce the social savings rate, increasing the uncertainty of China's capital accumulation, thus the negative effect on capital intensive industries is relatively severe; and (3) the age structure of the population changes will reduce the amount of consumption, and change the consumption structure, thus the demand for service is rising, and, correspondingly, the pulling power of related industries on the economic changes.

3.5.2. The Influence of Population Ageing to Gross Domestic Product (GDP) and Its Components

Assuming the growth rate of labor supply in 2010–2030 is the same as the growth rate during 1990–2010, the other parameters and variables are consistent with the baseline scenario.

From the simulation results in Table 8, it can be seen that GDP growth rate at the base scenario in 2010–2015 keeps a rate of 9.02%, but the economic growth shows a declining trend; in 2025–2030, GDP growth rate goes down to 5.22%. Compared to the scenario without ageing assumption, i.e. the population growth rate stays at the 1990–2010 level with other conditions constant, GDP growth rate keeps a rate of 11% in 2010–2015, and, when it comes to 2025–2030, GDP growth rate keeps at 10% on average, almost double the base scenario, which indicates that demographic gift did pay an important role in promoting China's economy. When it gradually disappears, China's economic growth will slow down continuously without other policy stimulation.

Table 8. GDP growth rates of the base scenario and the no ageing scenario (%).

Scenario	2010–2015	2015–2020	2020–2025	2025–2030
Ageing	9.022	7.233	6.467	5.223
No Ageing	11.139	10.727	10.446	10.018

Furthermore, from the GDP components view (Table 9) and under the background of population ageing, population ageing has little influence on consumption and investment to GDP ratio. This is mainly because the model assumes that the government does not introduce any stimulating consumption or investment policies. In exports, there is a big difference in the no-ageing scenario and base scenario. In the no-ageing scenario, the average contribution rate of export rises to 45.60% in 2030 from 28.54% in 2015, while under the base scenario, the average contribution rate of export is 38.22% in 2030. The population ageing makes the total labor force decline, labor costs rise, and the comparative advantage of low labor costs decline. Therefore, the pulling effect by exports to economic growth will continue to decrease. It is worth noting that the population growth slowdown will affect the corresponding proportion of consumption and investment. Although the proportion of the consumption and investment accounted for GDP changes little, from the absolute number, its growth rate is lower than that in the population ageing scenario. For example, in the context of population ageing, the contribution rate of consumption and investment is 45.621% and 51.569%, respectively, in 2030, while, in the no-ageing scenario, those respective values are 46.146% and 50.620%. Therefore, the government should adopt policies to stimulate consumption, actively expand domestic demand, and enhance the basic role of consumption on economic growth, while increasing and guiding private investment to play a key role in investment of economic growth.

Table 9. GDP components of the base scenario and the no ageing scenario.

	Scenario	2015	2020	2025	2030
Consumption	Ageing	48.731	47.813	46.618	45.621
	No Ageing	49.022	48.023	47.235	46.146
Investment	Ageing	47.686	49.321	50.565	51.569
	No Ageing	47.351	48.563	49.837	50.620
Export	Ageing	28.537	30.748	34.231	38.228
	No Ageing	28.967	32.633	38.360	45.638
Import	Ageing	−25.223	−27.915	−31.564	−35.537
	No Ageing	−25.460	−29.328	−35.262	−42.262
GDP		100	100	100	100

4. Discussion and Conclusions

The abovementioned labor force sustainability measures indicate that the labor supply will have peaked in 2014 and then will decline annually. Furthermore, China will have faced a labor pressure after 2015. Indeed, according to the National Bureau of Statistics [41], China's working age population (16–65) in 2015 is 1003.61 million, showing a downward trend for the second consecutive year; at the same time, the proportion of working age population reached 73%, decreased by 0.4 percentage point compared with 73.4% in 2014. While the labor participation rate maintains a declining trend as Feng [42] found throughout his sample period (2002–2015), the results generally accord with prediction made before, which proves the correctness of the model. Thus, according to the existing level of economic development and economic structure situation, the labor force imbalance (shortage) will gradually increase after 2017. The labor supply will not meet China's needs for an economically sustainable development.

In fact, a structure contradiction exists in the labor market, which means that labor shortage and oversupply exist simultaneously. According to the supply and demand law, those industries with fast wages increase and high-pay face labor shortage because they demand people with high quality or skills, while those industries with slow wages increase and low-pay face a serious labor shortage. The oversupply of labor pertains mainly to people with few skills that include the labor working in the informal industries. Those people who work in informal industries with low income and bad working environments are not included in the statistical data. Over the past decade, China has conducted a total of three census surveys: the sixth census in 2010 [43], census of 1% population sample survey in 2005 [44], and the fifth census in 2000 [45]. However, unfortunately, unlike the census of 1% population sample survey in 2005 [44], the two other censuses did not provide information on the type and employment status of workers. Therefore, the 1% population sample survey data in 2005 are the most authoritative data of the current study of China's informal employment size and characteristics. The proportion of non-agricultural employment of Chinese cities and towns in informal employment is 58.85%. Because the employment number is 277 million in 2005, the number of informal employment should be 163 million. If this large number of informal workers is taken into account, the gap of labor force demand and supply will be put off to 2036 in the econometric model prediction, 2030 in the elasticity method at 6% GDP growth rate, 2028 in the elasticity method at 8% GDP growth rate, and 2026 in the elasticity method at 10% GDP growth rate.

Form the shock of labor supply declining, the contributions of most industries to GDP are showing a negative growth trend. From a medium- and long-term point of view, the influence of population ageing to the labor-intensive industries is the most serious. The construction industry's contribution to GDP growth rate still

shows a rising trend, but the growth rate decreases annually. The service industry's contribution to GDP growth rate shows a significant upward trend, but the rate is decreasing annually. The economic growth shows a declining trend. Population ageing has little influence on consumption and investment to GDP, but from the absolute number, its growth rate is lower than that in the population ageing scenario. The pulling effect by exports to economic growth will continue to decrease.

In this study, a labor force sustainability model is constructed by using population ageing CGE mechanism to study the impact of labor force supply and demand to the economically sustainable development in the future. This study shows how the model can be used to predict the future population structure, and then calculate the balance of labor supply and demand, and shows how the labor force imbalance affects the macro-economy, specifically the outputs of different industries and the levels of consumption and investment of the economy.

Since the population ageing will slow down China's economic growth and hinder the improvement of living standard, the government should take active measures to deal with the challenges of population ageing. Increasing the total fertility rate to slow down the rate of population ageing to reduce the negative impact of population ageing on economic growth is one of the most popular international policy measures. However, the Australian Productivity Council's simulation study found that raising the fertility rate to cope with the problem of population ageing is not a wise choice for Australia. From 2000 to 2045, the impact of fertility increase will raise not reduce the total dependency ratio in Australia. The impact to GDP of increased education expenditure and subsidies for families and child care caused by fertility rate will exceed the impact to GDP of increased health and elderly care expenditure caused by population ageing [46]. The most appropriate public policy to address the negative impact of population ageing is not a policy that will bring another problem [47]. Technological progress and productivity improvement are the fundamental ways to deal with the negative impact of population ageing on economic growth. The results of this model also found that in the case of population ageing, technological progress is the core of sustainable economic growth in China. Therefore, the government should actively take measures to stimulate the development of productivity. As some Western scholars have pointed out, although in the ageing of the population labor force will be shrinking, the increase of human capital stock will make the workers more intelligent and more productive, which is equal to the increase of labor supply [48].

Because of declining fertility, if the benefits that support families with children are not raised and the costs are not reduced, as long as the social pension system is running well, it is difficult to rebound the low birth rate. Continued low fertility rates will lead to a continuing ageing population, which in turn will make it difficult to maintain the social pension system. Perhaps only when the social pension system

breaks down, it may lead to a reconstruction of the social pension and foster system, and influence the fertility rate so that low fertility rate rebounds and returns to replacement level.

Germany, France, Russia, Singapore, Hong Kong, and Taiwan have taken a series of measures to support the family and reduce the cost of raising children in order to raise the level of fertility. The main measures include the government paying maternity period salary, tax cuts, monthly or one-time paid child subsidies, free education for children, providing housing subsidies or even offering free housing. Some high welfare countries under the severe stress of the population ageing in Northern Europe reform the old pension system in order to raise the level of fertility and reduce the pressure of pension payments. For example, Finland from the beginning of this century carries out the reform of the pension system through raising the retirement age, reducing the proportion of the average pension payments and the collection of pension tax.

China is constructing a social security system that covers the city and countryside, while the social pension system will be constructed gradually. China's population ageing is continuously increasing. Even if there is no birth control, it is still very difficult to increase the fertility rate for two reasons: China gradually formed a social pension system, and children are not required to care for their elderly parents as was traditionally common; and the urbanization process in China is advancing at a speed of nearly one percentage point each year, which discourages people having more children because it causes high living and educational costs. In 2015, the urbanization rate of China is 50%, while, according to the World Bank WDI data 2016 [49], the urbanization rate of developed countries is over 70%, within which the rates in the United Kingdom, the USA, and South Korea are 89.7%, 80.8%, and 80.8%, respectively. By comparison, the urbanization rates of developing countries such as Mexico, North Korea, and Mongolia are, 76%, 61.1%, and 56.7%, respectively. China's current urbanization rate is not only lower than the developed countries, but also lower than many developing countries. Even if the country does release birth control, the fertility rate may still be lower than 1.8. Therefore, China's population ageing will be a persistent and serious problem.

The population ageing problem needs to be paid more attention. From the mechanism of ageing, in the absence of other effective interventions, the ageing of the population will become a long-term feature in the future. We need to fully study the impact of ageing on the social economy. When we develop relevant social and economic policies, we should take ageing as one factor.

Also, a comprehensive view of the declining fertility rate is required. While China implements birth control policies, it does not have subsidies for children. Public transfer support is mainly embodied in the nine-year compulsory education. The elderly in urban areas obtain income through social pension system. Therefore,

in China's urban areas, social pension system is actually formed. According to this reality, declining fertility rates need to be carefully evaluated as well as whether the decline is decided by national policy control or families' choice so that current population policy and its implementation effect can be evaluated.

The birth rates of Japan, Korea, Singapore, Hong Kong, Macau, and Taiwan are the lowest in the world. Due to the very low fertility rate and the negative impact of population ageing, these countries encourage fertility but with little success. China needs to learn from their experience. Although China's population is large, the low fertility rate will bring many negative effects. The social security system needs to be improved, and the level of social pension needs to be determined reasonably. Because the pension system has a direct impact on fertility rate and the population ageing degree and the construction and reform of social security system, the selection of social pension level needs to be based on the considerations of a healthy population age structure. Appropriate pension standards should be related to the reasonable cost and benefit of child-rearing, and correspond with the reasonable proportion of resource transferring from the working-age population.

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Appendix

Table A1. Forecast of labor supply from 2014 to 2050.

Year	Population in 15–64 Age Group	Labor Supply	Year	Population in 15–64 Age Group	Labor Supply	Year	Population in 15–64 Age Group	Labor Supply
2014	977850287	779346679	2027	928576649	728004093	2040	826708835	637392512
2015	975328463	776361457	2028	917469464	718378590	2041	821509601	632562393
2016	972374894	773038041	2029	910601880	712090670	2042	817737174	628839887
2017	965744319	766800989	2030	902875829	705146022	2043	813294303	624610025
2018	958766844	760302107	2031	895606106	698572763	2044	808681362	620258605
2019	950946412	753149558	2032	890612342	693787014	2045	804902321	616555178
2020	942787922	745745246	2033	880739820	685215580	2046	801142632	612874114
2021	939119751	741904603	2034	872795781	678162322	2047	796092619	608214761
2022	933624923	736630064	2035	862747113	669491760	2048	793714195	605603931
2023	930324825	733095962	2036	854451796	662200142	2049	792060105	603549800
2024	930949222	732657038	2037	846665592	655319168	2050	790496583	601567900
2025	930637300	731480918	2038	839266030	648752641	—	—	—
2026	933650123	732915347	2039	832343598	642569258	—	—	—

Table A2. Forecast of labor demand from 2014 to 2050.

Year	Econometric Model	Elasticity Method at 6% GPD Growth Rate	Elasticity Method at 8% GPD Growth Rate	Elasticity Method at 10% GPD Growth Rate
2014	774059580	774971336	776704858	778438380
2015	778151839	780207817	783702192	787204375
2016	782055855	785479681	790762565	796069083
2017	785780285	790787168	797886545	805033617
2018	789333392	796130517	805074705	814099101
2019	792723056	801509970	812327623	823266671
2020	795956796	806925773	819645882	832537477
2021	799041783	812378171	827030072	841912681
2022	801984861	817867410	834480786	851393460
2023	804792557	823393740	841998624	860981002
2024	807471100	828957412	849584189	870676509
2025	810026429	834558677	857238093	880481197
2026	812464213	840197790	864960951	890396295
2027	814789860	845875006	872753384	900423048
2028	817008526	851590584	880616020	910562712
2029	819125134	857344781	888549489	920816559
2030	821144378	863137860	896554432	931185874
2031	823070736	868970083	904631491	941671958
2032	824908483	874841713	912781316	952276126
2033	826661692	880753019	921004562	962999708
2034	828334254	886704267	929301893	973844047
2035	829929879	892695728	937673973	984810505
2036	831452104	898727673	946121478	995900456
2037	832904308	904800376	954645087	1007115291
2038	834289709	910914112	963245484	1018456416
2039	835611383	917069158	971923363	1029925254
2040	836872259	923265795	980679420	1041523242
2041	838075135	929504302	989514361	1053251836
2042	839222680	935784962	998428896	1065112505
2043	840317436	942108061	1007423742	1077106737
2044	841361834	948473885	1016499622	1089236036
2045	842358189	954882724	1025657268	1101501923
2046	843308713	961334866	1034897414	1113905936
2047	844215512	967830606	1044220805	1126449630
2048	845080598	974370237	1053628190	1139134580
2049	845905891	980954057	1063120326	1151962374
2050	846693220	987582363	1072697977	1164934622

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Development of Environmental and Economic Sustainability Metrics for the Metal Production Industry—Experiences From University-Industry Cooperation

Roope Husgafvel, Nani Pajunen, Olli Dahl, Kari Heiskanen, Ari Ekroos and Kirsi Virtanen

Abstract: Numerous sustainability assessment methods, especially environmental performance evaluation tools, have been developed to assess environmental performance of the process industry. Typically, environmental performance indicators cover only primary emissions and consumption without any recognition of secondary environmental burdens from auxiliary processes outside the plant boundaries. Therefore, the environmental impacts of the production site might be decreased whereas the overall environmental performance is not necessarily improved. The overall objective of our research project is to develop a sustainability index that comprehensively and reliably captures the environmental, economic, and social sustainability of an industrial plant. In this paper, we present this work on environmental and economic sustainability metrics for the metal production industry and two hypothetical process industry case studies on the application of the developed metrics. We develop both appropriate indicators and an example of an environmental and economic sustainability index that is also tested in two process industry case studies. Our assessment approach integrates indicators and life cycle assessment by expanding the scope of the typical environmental performance indicators. By this approach, the evaluation not only concentrates on the activities at the plant site, but also covers the emission sources that are indirectly connected to the actual production process. As a result, this approach provides comprehensive information for decision-makers on both the environmental impacts caused by plant operations and economic implications of alternative decisions. In addition, we present a discussion of according EU and Finnish legislation and their implications for both the management and assessment of plant level environmental and economic sustainability performance.

Keywords: sustainability metric; environmental sustainability; economic sustainability; metal production industry; sustainability index; sustainability indicator; environmental law

1. Introduction

1.1. Background

In recent years, the number of sustainability assessment methods that aim to evaluate the sustainability of companies' practices and processes has increased. In general, increasing awareness of environmental issues has led to a situation in which the production industry needs to pay more attention to the development of more sustainable products and manufacturing processes. Although the concept of sustainable development or sustainability has several definitions; the most common one is presented by the Brundtland Commission: "to make development sustainable—to ensure that it meets the needs of the present without compromising the ability of the future generations to meet their own needs" [1] (p. 16).

Several evaluation methods exist to assess the overall sustainability and environmental impacts of companies, processes, and products. Sustainability indicators have especially gained much popularity since the United Nations Conference on Environment and Development, held in Rio de Janeiro in 1992. One of the key outcomes of the United Nations Environmental Programme (UNEP) conference, the Agenda 21 action plan [2], encourages individual countries and organizations to develop sustainability indicators for the basis of decision-making. At the beginning, the focus was on the assessment of countries, regions, and policies; however, nowadays, sustainability evaluation has merged into the evaluation of companies themselves and their processes. Several tools and frameworks have been developed to assess the sustainability of a single company, and different approaches to assess environmental sustainability have multiplied over recent decades, including life cycle assessment (LCA) [3,4], environmental performance indicators (EPIs) [5,6], Material Flow Analysis (MFA) [7], and energy-based assessment methods, such as exergy [8] and emergy analysis [9].

Sustainability indicators have become important tools for providing information on corporate performance [10]. A considerable amount of research has been carried out in the field of sustainability assessment in general, but a uniform approach is missing to measure and compare environmental impacts. Even though the concept of sustainability is typically well understood, the methods available to measure and express progress towards sustainability have remained heterogeneous [11]. LCA is widely used to assess the environmental impact of the metal production industry [12–14].

1.2. Sustainability Metrics in the Process Industry Context

Despite the importance of all three dimensions—social, economic, environmental—of sustainability, sustainability performance metrics for environmental issues are the most common [15,16]. Environmental challenges have been recognized since the

early 1970s and environmental issues have an impact on many decisions, both at the political and organizational levels [17]. Therefore, several tools have been developed to assess the environmental performance of the process industry. The purpose of the environmental performance tools is to provide relevant information for decision-makers. "One of the main goals in decision-making is to identify and choose the most sustainable option from among different alternatives" [18] (p. 1), meaning that decision-makers should have enough relevant information about the environmental impacts of different alternatives and about how they affect the companies' performances, as well as about their impacts on the surrounding environment, society, and economics. However, several different approaches exist to evaluate environmental performance, each with their own key characteristics and mechanics including the provision of information for different purposes.

However, it is not clear how these assessment methodologies should be applied comprehensively at the operational plant or installation level. In general, production industries are faced with the growing demands for improved environmental and social performance and at the same time they are required to sustain their economic competitiveness. Similarly, even though industrial plants create pollution, industrial activities also create wealth and well-being for the surrounding society [15]. In addition, national and international legislation set requirements for plant level operations, which need to be taken into consideration. Sometimes local regulation might even be in contradiction with global sustainability goals. Especially, measurements of environmental impacts are not straightforward, with the reduction of an emission that contributes to one environmental problem causing higher emissions contributing to another environmental problem [19]. This may apply to local and global environmental impacts as well, such that improvements in environmental performance locally might lead to increased environmental burden in the broader global context.

There is no clear definition for the difference between indicators and indices [20]. However, indices have been considered to encompass a higher level of aggregation than indicators [21–23]. Since indicators include a wide variety of data with different range of values and measuring units, it is necessary to standardize the data. By standardization, the values are converted into one comparable scale, prior to weighting and aggregation [22,23]. Weighting and aggregation of data might have a significant impact on the output: depending on the chosen method, the results might vary significantly even when using the same dataset [22]. Compressing data to form composite indicators can involve losing underlying data, thereby increasing the uncertainty [24].

Composite or summary indicators have been acknowledged as a useful tool to condense information and reduce the decision-making criteria [15,21]. Indices can provide an overview of relevant progress, but also highlight problem areas. Indices,

such as the Dow Jones Sustainability Indices [25] and the Financial Times Stock Exchange FTSE4Good Index Series [26] and the Global 100 Index [27] are widely used to rate companies according to their sustainability performance. Indices are also developed for plant level evaluation; for instance, the Composite Sustainability Index for Steel Industry by using the Analytical Hierarchy Process (AHP) [21], or the Industrial Sustainability Index (ISI) [28], which is a general framework for industries. Indices can provide relevant information for decision-makers in a concise manner; however, the weighting and aggregation methods might lead to skewed or misrepresented results.

Environmental indicators have been recognized as a valuable tool providing simplified and concise information from a vast quantity of environmental data. Environmental indicators have many roles and purposes; they can be used for measuring a plant's performance over time or for comparison between plants (benchmarking), as a communication tool for internal and external use, and as a measuring stick to follow progress towards some specific environmental targets [5,6,23]. However, their most important task is to provide relevant and concise information, since good decision-making requires correct and relevant information [29]. Therefore, any set of indicators must be relevant to their intended application. In addition, indicators should be easy to understand, be measurable, target-orientated, and represent substantial subjects of the industry [5,30].

Environmental Indicators (EIs) can be divided into Environmental Performance Indicators (EPIs) and Environmental Condition Indicators (ECIs), as shown in Figure 1. EPIs consist of Management Performance Indicators (MPIs) and Operational Performance Indicators (OPIs). MPIs measure management efforts to influence companies' environmental performance whereas OPIs measure the environmental performance of operations [5,20]. In most cases, when evaluating environmental sustainability, operational performance indicators are employed and only minor importance is given to environmental condition indicators. ECIs are used to provide information on local, regional, national, or global conditions of the environment [20].

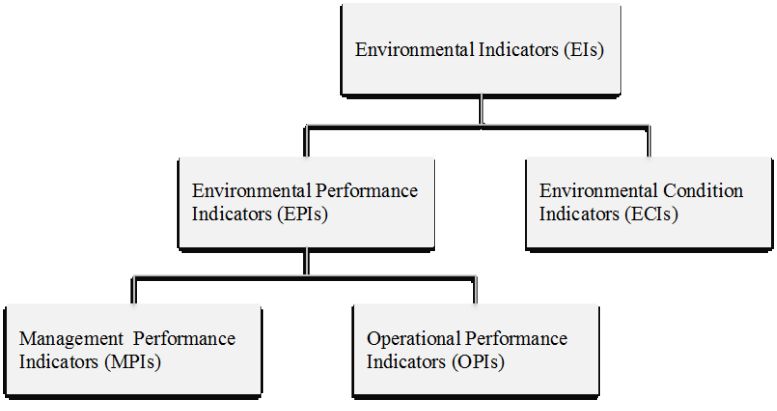

Figure 1. Categorization of environmental indicators [20].

Several methods that utilize environmental performance indicators have been developed to assess the sustainability of industry. Both general and sector specific Sustainable Development Indicators (SDIs) have been proposed in the literature [15,31]. SDIs should be sector specific to capture the key characteristics of specific industrial sectors [28]. Besides SDIs having been developed for individual companies and processing sites, such as SDIs for the mining and mineral industry [15], SDIs are also employed to evaluate and follow sectors' progress towards sustainability [31]. For example, the World Steel Association [32] and European Aluminum Association [33] have both developed their own sets of SDIs for sustainability assessment of their industry sectors. Even though indicators have been recognized as a valuable tool to gather and present information for different purposes, evaluation and decision-making might be difficult based on many indicators [20]. Therefore, summary indicators or indices have been recognized as a suitable technique to summarize the information provided by multiple indicators.

1.3. Rationale of the Study

The general purpose of any environmental legislation is typically to directly or indirectly determine what kind of activities are allowable, including various permitting aspects that control operations. The legislator defines the appropriate level of activity that applies generally to all operators, for example, via a prohibition to use certain substances or processes altogether. In Finland, industrial activities are regulated by the Environmental Protection Act (EPA) [34], which states that an environmental permit is required for all activities that pose a threat of environmental pollution. Activities subject to a permit are detailed in the Environmental Protection Decree [35]. The objective of the EPA is to prevent the pollution of the environment and to repair and reduce the damage caused by pollution; to combat climate change

and otherwise support sustainable development. According to the Decree, permits must contain necessary conditions covering the following aspects [34] (p. 19–20):

(1) emissions, emission limit values, the prevention and limitation of emissions, and the location of the site of emission;
(2) wastes and reduction of their quantity and harmfulness;
(3) action to be taken in case of a disturbance or in other exceptional situations;
(4) measures to be taken after the cessation of operations, such as remediation of the area and prevention of emissions;
(5) other measures to prevent, reduce, or assess pollution, the risk thereof, and adverse effects caused by it.

The environmental permit procedure takes account of the environmental impacts of the industrial operation as a whole [36]. Yet, it could be questioned whether the targets and environmental outcomes will be satisfactory in the bigger picture. The challenge does not necessarily relate to the environmental legislation itself but to its application in practice. For example, the requirement to use best available techniques (BAT) could be understood as allowing a rather expensive and holistic evaluation. Section 4 of the EPA mandates the use of BAT, and according to Section 43.3, permit regulations concerning emission limit values and their prevention and limitation must be based on BAT [37]. Moreover, the BAT requirement does contain a principle of proportionality, since while the requirement refers to using the most efficient and advanced methods of production possible, the required methods must also be economically (i.e., economically viable within the industry excluding individual company profitability) and technologically feasible [34]. Furthermore, Article 9(4) of the Integrated Pollution Prevention and Control (IPPC) directive refers to considering the technical characteristics of the installation concerned, its geographical location, and the local environmental conditions. However, Article 9(4) of the IPPC directive subsequently refers to ensuring a high level of protection for the environment as a whole [37]. The Industrial Emissions Directive (IED) [38] introduced many requirements on permits and the associated control of emissions. Article 13 of the IED promotes the application of BAT reference documents and the associated exchange of information. Also, according to Section 43(3) of the EPA [34], the impact of the activity on the environment and the significance of intended measures to prevent pollution of the environment must be taken fully into account. Together, these provisions clearly enable the evaluation of proportionality. An expansive reading of this provision would also allow for considering global sustainability concerns—for example via increased energy use—, even when the BAT principle must be complied with.

Environmental authorities in turn introduce more specific regulations covering plant-level activities, for example, via emission levels in an environmental permit.

Both legislation and the more specific administrative regulations define the level of environmental impact the operator is allowed to cause during its operations. The environmental impact assessment is, however, usually limited in its scope to local or regional effects, as is the scope of the legislative act regulating the activity or the competence of the environmental authority. Authorities cannot take global sustainability effects into account as this would involve exceeding their competence. Instead, authorities are required to ensure the level of local environmental protection as defined in their legislation. For example, authorities might be required to order the reduction of local particle emissions. However, the operation of filtering equipment could entail a substantial increase in energy consumption, having a significant impact on CO_2 emissions and introducing an additional waste residue needing special treatment, handling, and disposal. The increased energy consumption could also run counter to energy efficiency obligations the operator is also faced with. Despite this potentially contradictory situation, authorities might find themselves unable to consider global sustainability impacts or other policy areas without overstepping their competence. The competence of an authority is determined politically in the legislative process. Ideally, all legislation and competences are coordinated perfectly, and harmful cross-effects are minimized. Given the complexity in the interrelation of local and global environmental problems, it is often likely that it is difficult to accomplish a holistic approach in individual cases. A further issue relates to the sensitivity of the local receiving environment, wherein emissions into a highly sensitive watercourse, for example, may require stricter discharge limits than those that may be generally imposed elsewhere for the same type of process effluent.

2. Aims of the Study

The overall objective of our study was to develop a sustainability index that comprehensively and reliably captures the environmental, economic, and social sustainability of an industrial plant. This novel sustainability index is aimed at supporting informed decision-making by integrating all the relevant dimensions of sustainability through the application of a single tool. In addition, the index could be used as a communication tool for stakeholders such as environmental authorities and local communities. Our approach to plant level sustainability measurement is presented in Figure 2. However, in this paper, we concentrate on environmental and economic sustainability at the operational plant level and especially on how to measure it. The main part of the work was focused on the identification and selection of (1) environmental performance indicators (EPIs) supported by appropriate Life Cycle Assessment (LCA) methodologies and (2) economic performance indicators supported by the consideration of what plant level sustainability costs. We also present two hypothetical case studies (a particle emission collector and a wastewater treatment unit) as examples of a plant level application of the environmental

sustainability index tool in practice. The development work for economic indicators is presented including a draft set of indicators and some hypothetical application considerations. The emphasis lays on the suitability of the selected approach to support decision-making processes at the plant level. Therefore, the impacts and costs of different actions should be integrated into the overall assessment. This paper, however, focuses on environmental performance aspects. We propose that the specific characteristics of the metal production industry should be addressed jointly with the relevant legal operational environment. Our purpose was to discuss the implications of the legal framework in the context of sustainability assessment, including its implications for environmental performance measurement in general. We also offer our recommendations on what environmental and economic sustainability assessment at the plant level should encompass to be able to provide relevant information for decision-makers.

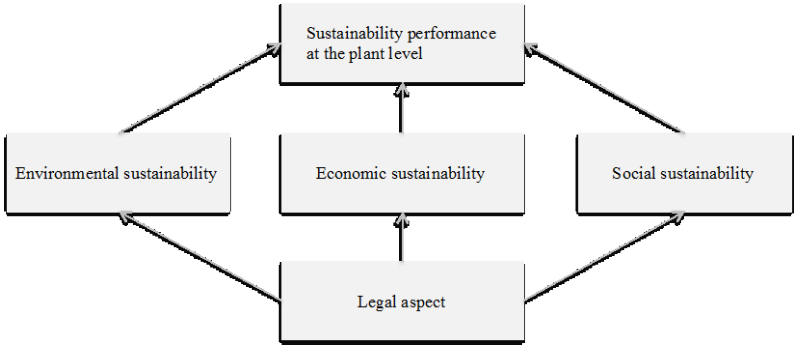

Figure 2. Different dimensions of sustainability assessment at the plant level.

The sustainability assessment tool covers environmental, economic, and social sustainability dimensions. However, a desired outcome should be able to adjust to different political and legal environments as well. Therefore, the legal aspect is included in each sustainability dimension to represent the extant legal requirements.

3. Material and Methods

The present research approach is based on both literature review and co-operation with industry partners. University-industry co-operation was arranged through workshops during the years 2012 and 2013: social indicators (28 February 2012), environmental indicators (16 March 2012), legal aspects (5 September 2012), and economic indicators (26 February 2013). This study focuses on the environmental economic parts including the associated legal aspects. By organizing these workshops, we aimed to gain a better understanding of the specific characteristics of sustainability assessment within the metal production industry and reach a common understanding of suitable indicators for the developed holistic sustainability index.

The material of the literature review covered public documentation, legislation, and the scientific literature in this field. The actual development work for the assessment method and associated details was carried out in co-operation with representatives from the participating companies. Life cycle thinking and assessment methodology [39,40] were a part of the environmental indicators' development work. Hypothetical cases of pilot testing of the developed environmental and economic indicators are also presented to demonstrate the potential and features of the chosen approach.

4. Development of the Environmental Sustainability Indicators

The purpose of the developed assessment method was to encompass the environmental issues relevant to the metal production industry. The scope of environmental indicators was expanded from a "gate-to-gate" approach to cover "cradle-to-gate" environmental impacts caused by raw material production and transportation. The development of appropriate indicators requires the identification of the relevant stakeholders and understanding their interests [15]. Therefore, the development work for the indicators was conducted with the co-operation of industry partners (Figure 3).

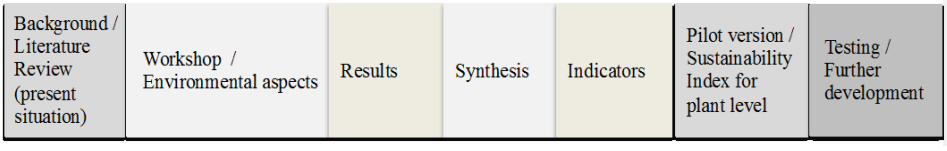

Figure 3. Structure of the development of the environmental indicators.

With this approach, the key characteristics and the most relevant sustainability challenges of the industry sector were identified.

4.1. Environmental Indicators

The development of environmental indicators included literature review and collaboration with industry partners through discussion-based workshops, for example, on environmental indicators (16 March 2012) and legal aspects (5 September 2012), which are the focus of this section. The legal indicator development work in the context of environmental indicators addressed planning of operations, environmental permit procedures, water aspects and permits, permits and associated operational aspects of plant operations, supervision and monitoring (by authorities), and close down phase activities and responsibilities.

One of the main questions that arose during the workshops was the required level of detail for plant level assessment. This refers directly to the number of indicators. An excessive number of indicators might be too heavy and time-consuming to use,

but too narrow an approach might lead to a lack of relevant information. The opinion of the industry partners was that without details the evaluation method would be without value. Therefore, we did not limit the number of indicators. However, the individual indicators were grouped as composite indicators, presenting a general overview over the environmental indicators (Table 1).

The most important environmental issues for the metal production industry are associated with air emissions, water effluents, and generation of solid wastes. In addition, depletion of non-renewable resources and primary energy demand including related CO_2-emissions are also significant. Therefore, selected environmental indicators reflect these key environmental issues. Furthermore, life cycle thinking has been included by broadening the scope of the evaluation to cover environmental impacts caused by raw materials production and transportation.

Table 1. Developed environmental sustainability indicators.

Summary Indicators	Indicators	Provides Information on
Air emissions (E_{AIR})	CO_2 SO_2 NO_x Dusts Metals	Contribution to global warming Contribution to acidification Contribution to acidification Contribution to local/regional air quality Contribution to human health and eco-toxicity
Water effluent (E_{WATER})	Total effluent flow	The amount of process waters that are returned to environment
	Quality of discharged water, measured by water quality parameters and discharged substances, such as suspended solids, Chemical Oxygen Demand (COD) and Biological Oxygen Demand BOD, oils, nitrogen, phosphorus, heavy metals and other harmful substances	Contribution to several environmental impacts, such as eutrophication, oxygen loss, impact on organisms, etc.
Solid residues (E_{SOLID})	Solid wastes Hazardous wastes Utilization rate	The quantity of solid wastes that are generated during the operations Utilization rate contributes to the ability to utilize generated wastes
Efficiency (E_{EFF})	Energy efficiency Material efficiency Water efficiency	Indicates the contribution to the global challenges regarding primary energy demand, consumption of non-renewable materials, and fresh water consumption
Production of raw materials (E_{RAW})	Primary material consumption Energy consumption Water efficiency CO_2-emissions	Influence of the raw materials and energy production
Transportation (E_{TRANS})	CO_2 SO_2 NO_x Primary energy demand	Influence of the transportation
Total GHG-emissions (E_{GHG})	CO_2-eq.	Summarizes CO_2-eq. emissions from all the production steps from cradle to gate
Legal aspects (E_{LEGAL})	Planning operations Permit procedure Water management permit During operations Monitoring Ending operations	Indicates the level that local legislation steers the plant operations and environmental impacts

The first three categories consist of relevant emissions contributing to air, watercourses, and land. CO_2, NO_x, SO_2, dust, and heavy metal emissions are common for the metal production industry sector, whereas the water quality parameters are modified for each process separately. One major environmental challenge in the metal production industry is solid waste generation. There are several sources of solid wastes: dusts, water treatment sludge, and process slags. The solid residues category covers the amount of produced solid and hazardous wastes. In addition, the utilization rate of solid residues expresses the ratio of the solid residues that can be utilized further.

The efficiency category encompasses energy, material, and fresh water consumption. Energy efficiency is determined by the amount of consumed fuels and electricity. Produced energy, such as district heat, is also included. Total non-renewable material intensity and amount of recycled material in the process are used as a measure of material efficiency. Since the metal production industry is typically a very material intensive sector, the utilization of renewable resources and recycled materials might have a remarkable effect on the virgin non-renewable material consumption. Therefore, it is an important factor to determine how much recycled and renewable materials processes can utilize. Water efficiency is simply assessed by measuring the specific fresh water consumption. This value indicates how much added make-up water is required in the process. Plants with more efficient water recycling systems and closed water-circuits naturally consume less fresh water.

The environmental impacts of raw material and energy production are included by evaluating the most relevant sustainability issues, which are (1) material consumption, (2) CO_2 emissions, (3) primary energy demand, and (4) fresh water consumption. The main virgin raw material in this sector is ore and the quality of ore deposits are decreasing [41]. There is potential for the reduction of energy consumption and associated greenhouse gas emissions in the metal extraction stage of the metal production life cycle. The type of reductant used is an important factor, especially in iron and steel production. In addition, utilization of biomass as a source of carbon can improve the sustainability of primary metal production [41]. In addition, emissions that arise from electricity production might have a significant role depending on the amount and origin of the purchased power.

Long distances are typical for the metal production industries' transportation, as large amounts of raw materials are transported to the processing sites. Transportation covers only a small part of the environmental impact of the production chain, but, globally, transportation plays a significant role. Transportation contributes to almost 19% of greenhouse gas emissions worldwide [41] and it is therefore an important factor in sustainability evaluation. Emissions of CO_2, NO_x, SO_2, and primary energy consumption are taken into consideration in the calculation. Emissions of CO_2 and NO_x are specific for land transportation. Furthermore,

SO_2 emissions are included, as those are relevant emissions for marine transport, especially in Europe.

In addition, greenhouse gas emissions (CO_2, N_2O, CH_4) have been calculated through the whole supply chain covering raw material production, transportation, processes at the plant site, and purchased power generation. The purpose of this indicator is to reveal the main sources of greenhouse gases and the overall impact of the production route.

The legal framework and specific national legislation do not evaluate the concrete performance of industrial operations but regulate the limits within which industry can operate, and thus a review of existing legislation can shed light on how well the legislation steers the plant operations in terms of, for example, environmental performance. In summary, in this study, the legal indicators were designed to describe both the EU and the national level legal environment and control mechanisms of Finland relevant to industrial operators in Finland. The evaluation of relevant environmental legislation is important and enables the description of the minimum level of environmental protection and of the associated enforcement control mechanisms in a given country. In this manner, the legal aspect indicators provide information on the extent to which legislation and local authorities are able to address environmental sustainability issues concerning industrial operations.

4.2. Evaluation Method

When condensed information is required, individual indicators need to be normalized on the same scale. To this end, this study employed the min–max method. For example, CO_2 signifies CO_2 emissions that are generated by the manufacturing process and the $CO_{2,Min}$ and $CO_{2,Max}$ denote the minimum and maximum CO_2-emissions of the specific industry sector, respectively:

$$EI_{CO_2} = \begin{cases} 0, if\ CO_2 \leq CO_{2,Min} \\ \dfrac{CO_2 - CO_{2,Min}}{CO_{2,Max} - CO_{2,Min}}, if\ CO_{2,Min} < CO_2 < CO_{2,Max} \\ 1, if\ CO_{2,Max} \leq\ CO_2, \end{cases}$$

where,

CO_2 = CO_2 emissions (kg/t product)
$CO_{2,Min}$ = Minimum value (kg/t product)
$CO_{2,Max}$ = Maximum value (kg/t product).

The minimum value presents the lowest emission level that is achievable with the current technology. Accordingly, the maximum value presents the highest acceptable emission level in Europe, and both the minimum and maximum values for

each variable are derived from Best Available Techniques (BAT) Reference documents (BREF-documents). When necessary, the reference data is complemented from other verified sources. A similar normalization method has been applied in a previous study [28].

At this point, no separate weighting method has been employed; however, it should be noticed that each category contains a different number of indicators and therefore they unequally affect the total score. In other words, some weighting occurs unintentionally due to the different number of indicators. Although these indicators were developed especially for the metal production sector, indicators need to be modified on a case-by-case basis. In addition, the reference values (min-max-values) need to be derived separately for each industry branch depending on the BREF guidance. However, even though the scope of the environmental sustainability assessment should be expanded to cover secondary emission sources, and decision-making should cover these aspects to discover the most environmentally sustainable solution, there are other factors that influence a company's environmental performance. One example is the national legal framework that regulates industrial operations.

5. Testing the Environmental Indicators in Potential Industrial Applications

The developed sustainability index focuses on plant level sustainability performance. The indicator tool can be used to help the company in decision-making and self-evaluation on the operations level, for example, when buying an existing plant, building a new plant, choosing between two possible investments (which would improve total sustainability the most?), and choosing a place and country in which to locate a plant. Although our approach in this article is mainly focused on assessing the environmental impacts, industrial activities also always have social and economic implications. Our hypothetical case examples are (1) a particle emission collector (Figure 4), and (2) a wastewater treatment unit (Figure 5). These case examples are evaluated with the developed environmental sustainability index tool. The evaluation is done before and after installing the investment. The change in the sustainability state is observed in two ways; does the index tool work and how can it be improved? The first hypothetical case example, and associated data collection, was carried out in collaboration with industry partners, and the second case example is about addressing high concentrations of Chemical Oxygen Demand (COD) organic compounds in chemical pulp mill wastewater. The purpose of this case example is to evaluate the situation of wastewater treatment before and after the specific investment. The energy and material inputs and outputs change due to the investment.

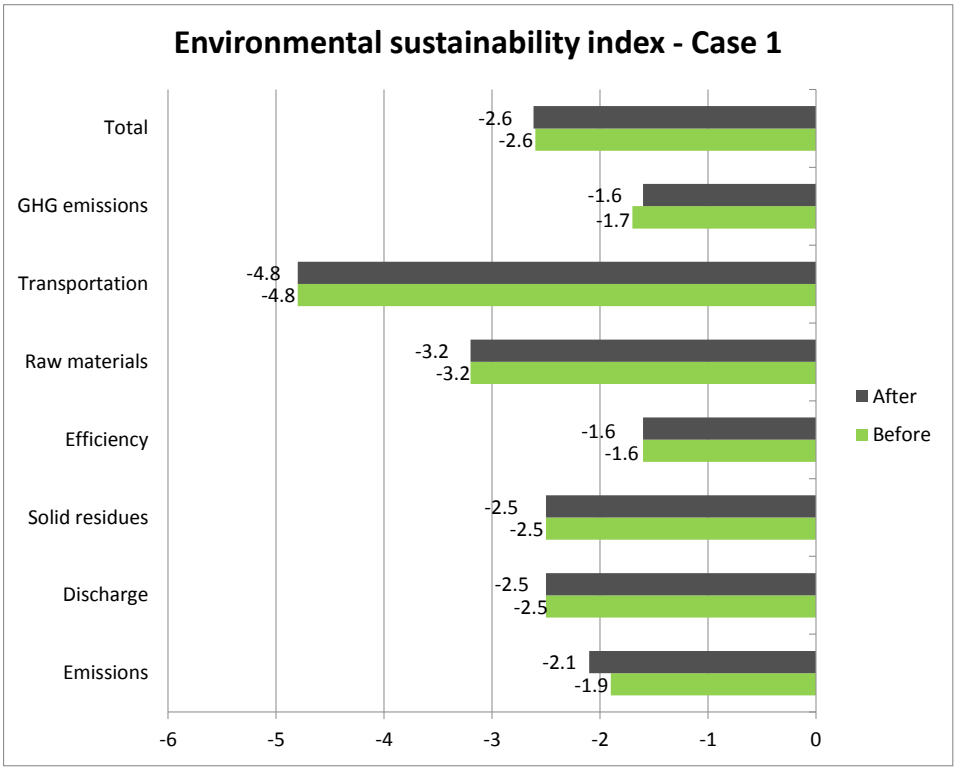

Figure 4. Case 1: Environmental index results for a particle emission collector before and after the investment.

Sub-indicators of the sustainability index were measured on a scale from -5 (best) to 5 (worst). The value 0 indicates that the given result is in the middle of the scale between the benchmark values [42]. The evaluation focused on a plant level hypothetical situation with realistic data. Because of the chosen scale, only the result of the emissions improved after investment. The case was discussed with industry partners in a workshop and they noted that in real life, the new particle emission collector worsened air quality inside the factory and thus had a negative impact on the working conditions of the employees.

The second hypothetical case example [42] is a wastewater treatment unit investment. It was required by authorities to reduce the quantity of Chemical Oxygen Demand (COD), high concentrations of organic compounds, in chemical pulp mill wastewater. The water was discharged into the surrounding waterways. Authorities demanded that the factory needed to purchase and install tertiary water treatment to reduce the amount of COD. The situation before and after this investment can be seen in Figure 5.

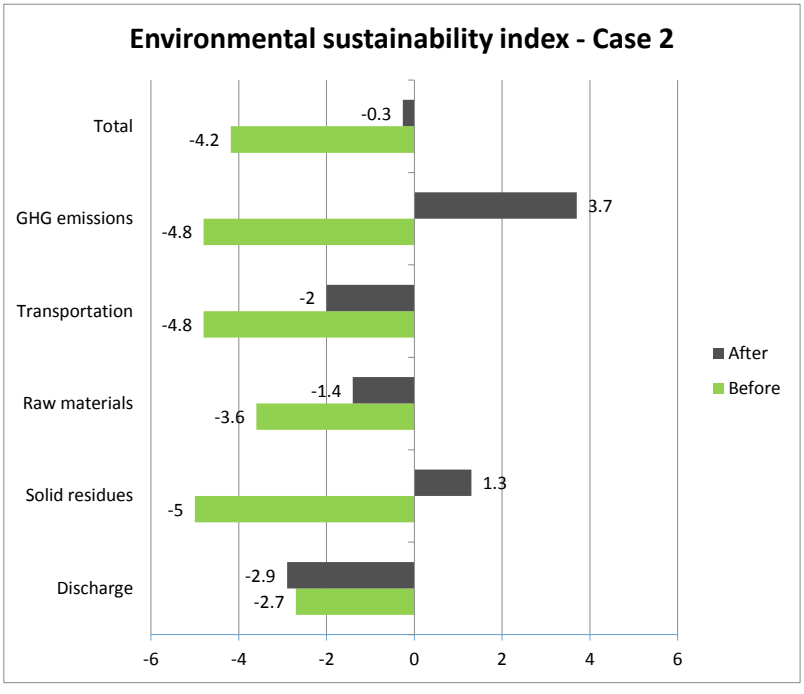

Figure 5. Case 2: Environmental index results for a wastewater treatment unit before and after the investment.

The tertiary water treatment reduced the amount of COD in the mill wastewater. However, tertiary treatment requires an aluminium sulphate as a water-cleaning chemical, hence the discharged sludge contains aluminium. In addition, the amount of such sludge increased due to this investment. Before the tertiary treatment investment, the sludge was disposed of in the bark boiler or recovery boiler inside the plant. After the investment, the sludge containing aluminium had to be taken to the landfill for disposal and the amount of landfilled waste increased significantly [42]. From the environmental perspective, the total influence of the investment was therefore a negative one. The sustainability index value before investment was -3.2 and afterwards was -0.6. The total environmental sustainability of the discharge cleaning unit deteriorated 2.6 units due to the investment [42].

6. Development of Economic Sustainability Indicators

Economic sustainability at the plant level is very much about long-term competitiveness, profitability, and meeting the demands of shareholders. Good performance makes it possible to generate societal well-being locally and to pay taxes. In addition, social and environmental responsibility and sustainability performance are very dependent on economic performance. However, companies need to

pay attention to responsibility, including stakeholder communication as well as putting strong emphasis on the well-being of employees and overall environmental responsibility. The general themes that were considered to be the main drivers in this study encompass the following:

- Plant level sustainability—What does it cost? How can it be measured?
- Cross effects—Can they be anticipated? How can they be communicated? What are links with social aspects? How can environmental and economic impacts be optimized?
- Economic consequences—What are they for various options and factors that influence plant level economic sustainability?
- Investment perspective—How to best invest a given sum into sustainability most efficiently? Do investments differ in nature?
- Risks—What are the supply chain, financial, and raw material risks?
- Legal framework—What are the specificities of national, EU, and global laws (e.g., regarding taxes and emissions)?
- Social responsibility—What are its cost effects, its effects on supply chain, and its image/brand risks?
- Corporation and plant level performance and assessment—How does a company/a plant perform? How can its performance be assessed, including internal and external applications?
- Communication—How to best communicate a holistic and balanced approach to sustainability to authorities (e.g., regarding assessments and permits)?

The developed draft set of economic indicators is presented in Figure 6. The workshop discussion covered multiple topics such as corporate social responsibility, societal dimensions and benefits of paid taxes, the need for robust economic performance to ensure a basis for long-term sustainability, cross effects and associated implications, sustainability in the supply chain and associated risks, image, public relations and brand aspects, global raw materials and suppliers, characteristics of environmental investments (compared to other investments), key business performance indicators, cost categories, different levels, and code of conduct.

The estimated economic implications [42] of the above presented hypothetical case studies (Figures 4 and 5) are presented in Figures 7 and 8. Calculations are based on realistic data and market prices. These examples highlight the cross-effect perspective in Case 1 in which minor environmental performance improvements may lead to significant negative economic impacts at the company/plant level and show how costs may increase significantly due to decisions made in the environmental performance context. The legal indicators in the economic context addressed retirement pension issues (e.g., insurance), disability pension, health insurance, accident insurance, and taxation.

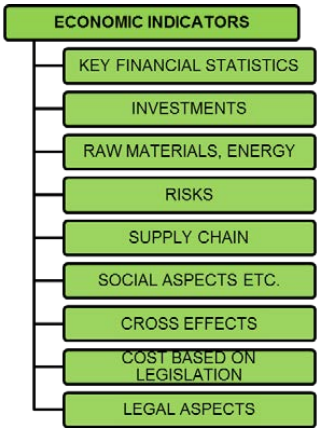

Figure 6. Draft set of economic indicators.

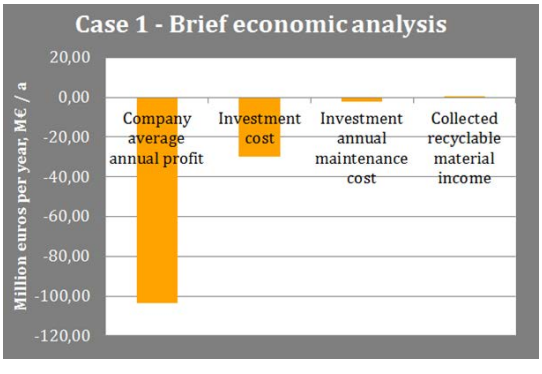

Figure 7. Example of the economic impacts in Case 1 (particle emission collector).

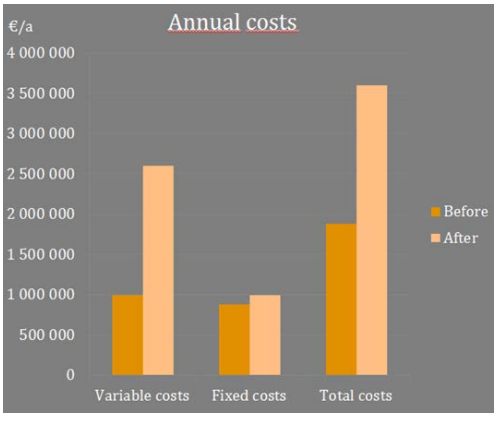

Figure 8. Example of the economic impacts in Case 2 (wastewater treatment unit).

7. Discussion

In this study, we focused on the development of an environmental sustainability index and associated indicators for plant level environmental sustainability performance assessment within the metal production industry. Our approach encompassed university-industry collaboration via workshops. Our premises included the idea that the application of sustainability metrics through indexes and indicators is a powerful tool for gathering and condensing plant level information to support informed decision-making. Our plant level approach is intended to encompass both primary and secondary emissions. Primary emissions are released from the plant activities, whereas secondary emissions arise from supportive activities, such as electricity production, which enable a manufacturing process. In accordance with life cycle thinking [6], we wanted to avoid problem/burden shifting even though full LCA studies are too laborious and costly, requiring professionals and large amounts of data for use in this context. Hence, our aim is to address the identification of cross-effects at the plant level using a comprehensive and balanced sustainability index approach. Any holistic approach requires focus on system level thinking. Our case studies highlighted the need to address cross-effects and problem/burden shifting through holistic and balanced approaches. A comprehensive sustainability index and associated indicators can be of much help in this respect.

Environmental performance and indices are usually focused on production processes without any recognition of the operations and their environmental impacts outside the plant boundaries. This kind of gate-to-gate approach risks problem shifting, indicating that the reduction of particulate emissions contributing to one environmental concern within plant boundaries might actually increase other emissions outside the boundaries contributing to another environmental problem [19]. For example, performance indicators should also cover the life cycle performance of products including, for example, resource utilization and transportation [6]. Other studies have also supported the idea of broader inclusion of relevant life cycle phases [19,43]. By broadening the scope of traditional EPIs to cover other life cycle stages as well, environmental problem shifting can be avoided. In addition, by constructing a composite index, the number of decision-making criteria can be reduced and the index can provide a comprehensive overview of environmental sustainability.

Traditional LCA could be developed towards a Life Cycle Sustainability Assessment (LCSA) that would be more similar to sustainability assessment covering all dimensions of sustainability [44]. Companies are interested in expansions of traditional LCA that include social, economic, and ecological aspects [45]. All these points speak in favour of a more comprehensive and integrated approach to the assessment of both overall and environmental sustainability. As we noted

earlier, cross-effects should be addressed within the overall plant level index. Other studies have made similar suggestions about addressing dynamics and interlinkages within the assessed system [46,47]. Our previous development work on social indicators and pilot testing experiences from the process industry have also been reported [48,49]. Regarding the overall evaluation methods, there are several different approaches [50,51]. Many previous studies have also addressed the economic aspects of decisions and measures to improve environmental performance [52–54].

The integration of environmental indicators and life-cycle assessment is implemented here to expand the scope of typical environmental performance indicators. Our original idea was that all the main environmental sustainability aspects could be covered using one assessment method. However, the possible drawback of this tool, as with many other indices, is the impact of normalization, scaling, and aggregation methods. During these types of operations, the real data behind such summary indicator values are lost. Even though sustainability indicators should be able to measure progress towards sustainability, the choice of reference values has a significant impact on the results. Therefore, it is important that decision-makers are able to observe the individual indicators behind the summary indicators. The summary indicators give a good general overview of environmental performance, but the underlying reason for poor or excellent performance should also be identifiable.

When trying to identify the most environmentally sustainable option, there is the challenge of how different emissions should be compared to each other. The first example is the type of emissions; when particulate emissions from process gases are reduced by scrubbing, it does not mean that the emission in question disappears, it only indicates that the particular emission is transferred from gaseous emissions to a water effluent or solid/sludge residues. The second example is how local improvements might affect overall global sustainability goals. For example, local particulate emissions can be reduced by electrostatic filters, which naturally increase the electricity consumption, hence affecting the emissions that contribute to electricity production. Especially when fossil fuels are used, CO_2 emissions are increased thereby affecting the main global environmental sustainability challenge, that of global warming. In this case, there should be a technique that enables the comparison of local and global sustainability in a reasonable manner. However, no uniform weighting procedure exists to rank different emission sources.

Furthermore, local authorities cannot consider global environmental impacts as their priority, for example, in their permit considerations. This is because the aim of controlling immissions and emissions is typically on controlling environmental impacts caused at the specific plant site and in its immediate surroundings. Possible proportionality assessments should be expanded from comparing the harm caused

by the emissions also to the harm caused by the operations on a significantly more extensive scale. This would include considerations of, for example, supply chain and the increased demand of materials or energy. In addition, when developing environmental performance metrics, monetary evaluation should be included if the method is employed as a decision-making tool within some company. By integrating monetary evaluation into the assessment method, the environmental impacts and costs of different actions can be evaluated.

8. Conclusions

In conclusion, this study suggests that environmental sustainability assessment should be expanded to cover at least the most relevant production steps beyond the conventional plant boundaries. As a result, problem/burden shifting can be avoided. It should also be noted that the application of this kind of sustainability index at the plant level always requires a case-by-case consideration of, for example, the features of the site and specific plant processes, and of the requirements for both quantitative and qualitative data. Environmental sustainability assessment at the plant level should be able to provide relevant information for decision-makers, considering the support of continuous improvement of the environmental performance of specific plant sites. The developed assessment method encompasses the main environmental issues relevant to the metal production industry at the plant level, while considering both operations beyond plant boundaries such as the environmental impacts caused by raw material production and transportation and location-specific legal aspects.

We are particularly pleased with the university-industry co-operation within this study that enabled the joint development of an appropriate set of indicators and associated methodological aspects. Joint development of the overall indices and the assessment tool was fruitful and led to many new ideas about further research and the identification of gaps that need to be bridged. For example, more research and development work is required to include monetary evaluation and social aspects into the evaluation method. Even though in this paper we concentrated on environmental and economic sustainability and associated measurements, the social and legal aspects of sustainability are at least equally important. The purpose of the plant level assessment tool is to provide information for internal use, but also to enable the assessment of environmental, social, and economic impacts on the surrounding societies and local economies, as well as of a plant's contribution to addressing global sustainability challenges. More development work is required, especially focusing on the evaluation of the cross-effects of different actions and the avoidance of problem/burden shifting. For example, our case studies clearly indicated the challenges associated with addressing the overall sustainability of dynamic and intertwined systems. The application of sustainability indicators as an evaluation tool seems to be an effective way for companies' self-evaluation of investments that

are made, including the assessment of associated impacts on operations both at the plant site and beyond its boundaries. Most likely, this approach can also be used for comparison between different plant sites inside a specific company. Further research, testing, and implementation of the developed index and indicators are currently under development.

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Collaboration and Competition in Local Energy Transitions: A Case Study

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Abstract: Cities and towns in Europe increasingly pursue low carbon transitions. Actors from different social spheres such as politicians, entrepreneurs, and scientists are involved in these local transitions processes. However, comprehensive research on these processes that takes the various social spheres and their interactions into account barely exists. This paper contributes to filling this gap by presenting an empirical study on the energy transition processes in the city of Emden (Germany). Based on document analysis and 37 narrative interviews with local actors involved in energy transition processes, it emphasizes the collaboration and competition between actors from different social spheres. The material shows an increasing engagement in energy transition processes, which can be attributed to the benefits various actors can generate from their activity in the transformation processes, such as political votes, power, economic profits, publications and research funds, credibility, and moral legitimacy. Despite seeking different types of benefits and engaging in dissimilar operational logics and fields of activity, actors from different spheres tend to complement each other in their transition activities. Thus, actors from each sphere assume specific functions in the local energy transition: politics take favorable decisions for local energy transition; businesses "materialize" energy transitions in the form of wind farms and energy efficiency measures; civil society agents act as moral watch dogs; science provides scientific expertise to transition projects. While the local activity is mostly marked by collaboration, there is also competition for the dominant positions in local energy transitions processes. Conveying high legitimacy and sphere-specific benefits to actors (e.g., votes, economic profit) as well as the potential to shape local transitions processes, actors compete for leadership roles and seek to brand themselves as pioneers of Emden's energy transition. The rising attractiveness of local energy engagement as well as the collaboration and competition between actors indicate the emergence of a local "energy transition"-arena, which constitutes a social field in which actors from different social spheres collaborate in energy transition activities and struggle for dominant positions.

Keywords: urban energy transition; actors; functions; social spheres; competition; arena

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1. Introduction

Social science research on sustainability transitions has expanded so much in recent years that today it forms its own research field. Different theoretical approaches exploring the dynamics of transitions have emerged in this field, and of them, the Multi-Level-Perspective (MLP) and Technological Innovation Systems (TIS) have particularly thrived (cf. [1]). Each approach assumes a specific perspective. MLP distinguishes between three levels of analysis: landscape, regime, and niche (cf. [2–8]). As dominant socio-technological configurations constitute regimes that tend to block potentially challenging innovations, protective niches allow for the experimentation with socio-technological alternatives. Niches and regimes are framed by landscapes, the institutional context that is not affected by short term variations on the level of regimes or niches. Landscape changes as well as niche dynamics may exert pressure on regimes and initiate transformations in dominant socio-technological configurations. The Technological Innovation Systems (TIS) approach, in contrast, draws a functional perspective on the development and diffusion of new technologies (cf. [9–11]). It identifies and explores specific functions in this process, such as the development and diffusion of knowledge, entrepreneurial experimentation, resource mobilization, and legitimization. The empirical analysis of the functions enables the identification of supportive and obstructive factors at different stages of the technological innovation process.

Despite exploring sustainability transitions from different perspectives, the two approaches share two characteristics that hamper their application to local transitions: (a) a disregard for the local and regional level and (b) a focus on (socio-)technological innovation. Implicitly focusing on socio-technological developments on the national and global level, prevalent theories tend to disregard the spatial dimension of transitions and particularly the local and regional dynamics [12,13]. Moreover, the aforementioned theories and related empirical studies center on the emergence and dissemination of technological innovations, significantly extending our knowledge of the conditions under which new sustainable technologies emerge and successfully spread. However, the technological focus of transitions research obstructs a more encompassing understanding of ST processes that takes the interplay of actors from various social spheres into account. Drawing encompassing pictures of sustainability transition processes that explore the interplay of actors from various spheres only appears feasible in small-scale regions, where researchers can identify all relevant actors involved in the given transition process and their interactions. Accordingly, local spaces such as cities, towns, and small regions may serve as empirical cases for generating more encompassing pictures of the complex interplay of actors in the course of transition processes.

As cities and towns in Europe increasingly pursue low carbon transitions, seeking more sustainable modes of energy production, consumption, and

distribution, there is rising research on transitions in these spaces (cf. [14–20]). Although this research usually indicates that different types of actors are involved and that their interplay is paramount for the intended transformation processes, little is for known about said interplay. As most research focuses on single projects and/or specific types of actors in cities and towns, we lack an understanding of how the local actors relate to each other in energy transition processes and organize their interplay.

This article addresses this research gap by exploring the interplay of actors from different social spheres in the energy transition processes of the German city of Emden. Placing a particular emphasis on the collaboration and competition between local actors, it raises the question whether the local activities indicate the development of a specific social field related to the local energy transition.

The study is based on an empirical investigation of Emden's energy transition process. In order to explore this transition process, different methods have been applied: (a) Document analysis: documents related to the process such as municipal plans, websites of local actors, and press reports were gathered and analyzed. (b) Narrative interviews: the author of the article conducted 37 qualitative semi-structured interviews with actors from different social spheres (civil society, finance, industry, intermediaries, municipal administration, politics, religion, science), who are involved in the local energy transition process. The interviews included questions about their main projects in the local transition process, the evolution of their activities in this field, and their relationships with other local actors.

The paper is structured as follows: The first section describes the main results of the research on Emden's energy transitions focusing particularly on collaboration and competition between local actors. The second section discusses whether the energy transition process leads to the emergence of a social field and portrays further research possibilities.

2. Emden's Energy Transition: Between Collaboration and Competition

Emden is a small harbor city of around 50,000 habitants in Northwestern Germany. The city's economy is marked by the shipping industry, its big manufacturing site of a German car builder, and increasingly by the wind energy industry. In the last decades, Emden's economy has experienced a transformation from its historically very strong shipbuilding sector towards the wind energy sector. With the decline of the shipping industry, several wind energy businesses have emerged (see also [18,21]).

The initiation of Emden's energy transition was characterized by solitary projects of single actors. The first project, which marked the beginning of Emden's energy transition, is the installation of a windmill at the local water works in 1987. For the moment, the attempts to create a local energy transition remained mainly restricted to

the public utility company and, perhaps to a minor degree, to actors in local politics and the city administration, who reinforced the projects of the public utility company.

In the 1990s and early 2000s, the number of projects, actors, and collaborations involved in the local energy transition drastically expanded. Due to a new legislation regarding renewable energy and rising social awareness about environmental change, engagement in energy transition became more profitable for many actors. Accordingly, more and more local actors from different social spheres such as businesses, political parties, and scientists started dedicating themselves to energy transition. By pushing energy-related projects, political actors realized that they could generate public recognition and employment in addition to gaining votes. Similarly, businesses saw new business opportunities related to the energy transition. For instance, businesses located in Emden's harbor discovered renewable energy, in particular offshore wind energy, as a promising business field: hit by downturn in its traditional business area, a local shipbuilding company re-orientated its business activities and started to construct windmill towers and platforms for offshore wind farms. Other wind energy businesses emerged in the harbor, while longstanding companies sought to integrate the new business opportunities into their strategies (e.g., transportation of employees and material to offshore wind farms). The local energy transition spread and became increasingly palpable. Large wind farms emerged in the outskirts of Emden, solar panels were installed in the city of Emden, public buildings were refurbished to low energy standards, and education programs and energy saving competitions at schools, as well as programs to increase the share of cycling and public transportation, were being implemented.

Given the strong commitment of the city to the low carbon transition and its ambitious climate targets—10% reduction of CO_2 emissions every five years and a 50% cut of the total CO_2 emissions from 1990 until 2030 [22]—alongside the implementation of numerous projects, and the engagement of numerous local actors, Emden is described as a pioneering city in Germany's energy transition [18,23,24].

Actors from various social spheres are involved in the local energy transition processes and implement a rising number of transition projects in Emden. Many of these projects are only feasible because of the collaboration of actors from different social spheres. For instance, the energy education "E-Spas" program at all public grammar schools in Emden is based on the cooperation of the city administration, local schools, the public utility company, and the local ecology center. Another example is the construction of the public utility's wind-farm at the site of a car manufacturer: local banks provided loans for the wind farm; the city administration handled the application procedures in a favorable manner; local politicians in the city council supported the construction politically; and the car manufacturer granted access to its site. A crucial alliance is that of three main actors: the mayor, the CEO of the Stadtwerke Emden (SWE), and the entrepreneur. Backed by their organizations

(public utility, governing party and municipal administration, and the consulting business), these three actors design and undertake various projects, spurring the local energy transition process (see also [18,23]). Although their interests and positions on sustainability may differ, they seek to balance their interests and undertake projects that fit their common interests.

Despite seeking dissimilar types of benefits and engaging in unlike operational logics and fields of activity, actors from different social spheres (businesses, politicians, scientists, ecological activists, etc.) tend to complement each other in their transition activities. Thus, actors from each sphere assume specific functions in the local energy transition: politics support the process with favorable political decision-making and contacts; businesses "materialize" energy transitions in the form of wind and solar farms and energy efficiency measures; banks provide specific loans for building retrofitting and the implementation of solar panels; civil society acts as a moral watchdog by voicing public protest and/or support; the local university trains future professionals in the area of energy efficiency, provides scientific expertise to transition projects, and conducts research projects together with local partners. Each social sphere contributes with its specific competences to the process. Accordingly, collaboration between actors from different social spheres is an essential feature of Emden's energy transition.

However, apart from collaboration, the local energy transition process is also characterized by competition. Over time, three different approaches to the energy transition process evolve in Emden: the *opportunistic vision* regards the energy transition mainly as a vehicle for generating profits (in the form of political votes, economic gain, scientific recognition, etc.). Many local businesses and some political actors take an opportunistic stance. The *counter-position* to this is the *environmentalist view*, which strives for ecological conservation. The ecological party, citizen initiatives, and environmental organizations assume the environmentalist position. Finally, there is a *position* that balances between the two aforementioned positions, seeking to promote environmental sustainability, but highlighting at the same time its benefits. Some business actors, such as local entrepreneurs and public utility companies, employees from the city administration, and researchers, tend towards this middling position. Actors seek to promote their vision of energy transition and struggle for public visibility and impact with their visions and projects. Accordingly, local businesses, the city administration, political parties, etc. launch public campaigns portraying their involvement in the local energy transition.

Struggling for public visibility and impact, some actors become more influential than others. Given its strong engagement and visibility, the public utility SWE enjoys a high reputation and is seen by the vast majority of interviewees as the central player in Emden's energy transition. The SWE invests strongly in wind farms, promotes energy efficiency among Emden's population, and creates strong alliances

with other powerful actors in the city. Holding a dominant position, SWE defines, to some extent, the predominant understanding of the local energy transition and the pathway of the transition process. It promotes a vision that balances between the opportunistic and environmentalist visions of the transition, focusing strongly on onshore wind energy production and energy efficiency.

However, other actors challenge the powerful position of the SWE and the predominant transition pathway. In 2008, the Danish power company *DONG energy* planned to construct a coal power plant in Emden. The plans were supported by some political and business actors, who regarded it as an opportunity to create employment and saw the potential of changing the prevalent energy transition pathway. However, the plans were met with strong objections from the population and some of the key actors of the local energy transition. Accordingly, these actors subsequently mobilized against the construction of the coal power plant, resulting in massive citizen protests in Emden's city center. In the end, *DONG energy* renounced its plans.

The preservation of the established energy transition pathway could be regarded as a further step in the petrification of the SWE's powerful position. Nevertheless, potential competitors such as the local university of applied sciences voice ambitions to become a leading figure in the local transition process. Consequently, competition about the pioneering role in Emden's energy transition is likely to thrive. Moreover, competition between local actors in the energy transition also relates to their interest in specific renewable technologies: while some actors linked to the onshore wind businesses in the region have vested interests in promoting onshore wind energy and portray offshore wind energy as inefficient, business actors related to the harbor and some politicians see their interests served by offshore wind energy (e.g., business opportunities in transportation of staff and material to offshore wind farms) and promote this technology within the region. Accordingly, apart from being marked by collaboration, Emden's local energy transition is also characterized by competition among the actors engaged in the local transition, as they follow different interests and visions.

3. Discussion: Emden's Energy Transition as a Social Field?

The rising levels of collaboration and competition may indicate the evolution of a particular social field related to the local energy transition process. To determine whether Emden's energy transition process has the characteristics of a social field, the concept of the social field has to be outlined.

Although defined in different ways by researchers, social fields are usually associated with some specific characteristics. Fligstein and McAdam [25,26] summarize some of the most prevalent features of social fields in their theory of *Strategic Action Fields*. They define fields as meso-level social orders in which actors

interact with knowledge of each other under a set of common understandings about the purposes of the field and its rules. Accordingly, fields are marked by the presence of several actors that follow a similar purpose and/or are dedicated to a similar subject. As they are taking each other into account, these actors mutually more or less know their activities and positions. Furthermore, there is action on the field: actors try to improve their positions and shape the field. In the course of the power struggles, the relationships are not only marked by competition, as some actors may also form alliances to compete others. Finally, the competition on the field results in the evolution of power inequalities: having gained a certain status within the field, some actors—defined by Fligstein and McAdam as "incumbents"—will assume a leadership position and have a particularly high potential of shaping the dominant pathway within the field. By contrast, actors that are less powerful but strive for the leadership constitute "challengers", as they seek to undermine the powerful position of the incumbent(s).

The aforementioned elements become manifest in Emden's energy transition: although the actors are primarily related to distinct social fields (e.g., economy, politics), they are all dedicated to a similar subject: the local energy transition. As Emden is a small city, actors involved in the local energy transition are usually aware of the other actors involved in the process and their activities. Additionally, actors compete and collaborate with each other. They compete over shaping the local transition process and often build coalitions among each other. Over the course of activities, hierarchies emerge: the SWE dominates the local energy transition, whereas other actors seek to challenge its influential position. In total, Emden's energy transition manifests the general characteristics of a social field.

As fields develop unique characteristics, so too does Emden's energy transition field show some particularities. The most striking characteristic is perhaps that it is marked more strongly by collaboration than by competition; whereas other transition processes are marked by strong conflicts between proponents and opponents of low carbon transitions (cf. [27,28]), in Emden, there is little conflict and a high level of cooperation between local actors. As Fligstein and McAdam [26] point out, some fields are rather based on collaboration than competition.

Another peculiarity of Emden's energy transition field is that it conveys actors that are primarily committed to other social fields such as businesses, politicians, and scientists. Standing in between different social fields (e.g., political fields, economic fields, and scientific fields) that follow particular logics and generate diverging notions of and interests in the energy transition, it constitutes a social arena that allows for negotiating and aligning these notions and interests. As such, the field assumes the role of coordination structure. Despite the seemingly coordinated contributions of the numerous actors involved, Emden's energy transformation process is not managed by any encompassing governing body. Instead, the field

appears to overtake this function: bringing these multifarious actors together within a shared social space, the field facilitates the communication and coordination between them. Mutual awareness of actors involved in the process, collaboration, competition, social networks, hierarchies, and to some extent the emergence of shared rules and understandings substitute a more organized coordinative structure in the case of Emden's energy transition. A specific field approach to sustainability transitions would have to highlight the coordinative function of social fields.

Furthermore, the case indicates that the local dynamics of collaboration and competition between different actors are crucial for the pathway of the local transition. Accordingly, the study of sustainability transitions needs a stronger focus on the interplay of different types of actors. Research in this direction could, for instance, explore and compare the dynamics of collaboration and competition in different urban transitions to determine typical patterns of this interplay.

Apart from comparative research on the dynamics of collaboration and competition in urban transitions, there is a need for theoretical approaches unfolding these dynamics. While existing approaches such as MLP and TIS have strongly contributed to explaining the evolution and diffusion of socio-technological innovations on the international and national level, specific theoretical approaches for the encompassing study of local transitions are, so far, missing. Theoretical approaches analyzing transitions at the local level would have to place an emphasis on agency and take the various types of local actors, their heterogeneous interests, and interplay into account. As this field approach focuses on the analysis of actors, their interests, and their interplay, it could constitute a valid contribution to this theoretical endeavor. However, to identify its potentials (and its flaws), and to further develop it for the specificities of local transitions, more research applying it to local transitions is necessary.

So far, there are only a few applications of field theory to sustainability transitions (cf. [27,28]). Further research may explore whether and under what conditions social fields develop in local transition processes. It may turn out that fields compensate for the absence of a governing institution, as they serve as a coordination mechanism. Moreover, research may also explore the benefits and limitations of a field perspective on sustainability transitions. As this perspective does not necessarily focus on the development and dissemination of particular technologies and takes various types of actors into account, it seems to allow for a more encompassing perspective on sustainability transitions than predominant transition approaches. Furthermore, as it avoids the regime/niche–dichotomy of the Multi-Level-Perspective, it may also provide a more dynamic and less structured approach to transition processes.

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