Cooperative Investment on Digital Communication and Sustainable Communities

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Abstract

Sustainable finance is expected to mitigate global crises. While the social and economic systems have been reformed to prevent further economic crises from occurring, quickly rising and serious problems such as Covid 19 pandemic, Climate Change, Ukraine war, have sequentially brought disasters in globalized communities. Great social risks probably bring problems beyond the range where the present system of economies and societies could offer the solutions. Sociaties and economies should evolve to aim sustainability. This article discusses theoretical exploration of global communities by presenting a sustainable scheme with multi stakeholders. However, digitization has changed largely scheme of social communication. Digital industrial revolution accompanies enlargement of market transaction and social information. Digitalization changes not only market economies but also cooperative structure of multi stakeholders. To make clear influence of digitalization on sustainable scheme of community stakeholders are divided into two types. One type has developed conventional or traditional transactions. The other type has grown by utilizing digital transactions or innovation of digital technologies. Where digital technologies bring uneven growth of stakeholders, this article explores voluntary contribution of multi stakeholders to construct sustainable cooperative schemes of communication investment.

To achieve the sustainable scheme of global communities every stakeholder is required to contribute cooperatively on sustainable investments. This article explores mechanisms of sustainable investment where multi stakeholders are induced to enhance cooperative communication as explained hereinafter. First, when many stakeholders become to be strongly connected with digital transactions, conventional stakeholders raise sustainable investment for communication. Secondly, the second type of stakeholders concerned with digital transactions triggers enhancing sustainable investment for communication. Thirdly, evolution of emerging sustainable investment enhances efficiency of communication.

Keywords: Altruistic coefficients; Cooperative communication; Digital industrial revolution; ESG (environment society and governance); Multi stakeholders; Sustainable investment

Abbreviations: ESG: Environment Society and Governance; CSR: Corporate Social Responsibility

Introduction

While the social and economic systems have been reformed to prevent further economic crises from occurring, serious problems such as Covid 19 pandemic, Climate Change, Ukraine war, have sequentially brought disasters in globalized communities. Great social risks probably bring problems beyond the range where the present system of economies and societies could offer the solutions. Sustainability of global communities could not be obtained simply by using well known knowledge but need to seek a breakthrough by integrating innovational results of many scientific fields.

Since the last decades of 20th centuries new liberalization and globalization had improved growth of global economies.

Globalization has accompanied digitalization and made problems of climate change more seriously. Rising innovation of digital technologies propels the fourth industrial revolution, Binz and Truffer [1] and Nyagadza [2]. Digitalization of global communities has brought fundamental transformation of communication mechanisms in global economies and societies Choudrei [3] describes. Revolutionary changes in both economies and societies require a sustainable communication mechanism to prevent global crises, as World Economic Forum [4] indicates.

The sustainable mechanism could be achieved by appropriate provision of global public goods. Stiglitz [5] illustrates some examples of global public goods by political stability, economic stability, the environment, humanitarian assistance,

and knowledge. This article explores that digitalized global communities provide global public goods to improve global sustainability. Enlarging global societies have accompanied innovation of intelligence technologies and changed economic and social system. Digital transformation has enlarged consumers and suppliers at the same time in the global markets. Growing global economies need cooperation with many stakeholders to achieve sustainable societies. Corporations have communicated not only with domestic markets and residents but also directly with foreign stakeholders such as consumers, governments, financial funds and environmental organizations. The sustainable framework explores mechanisms that any profit and non-profit organization can obtain incentives to improve social welfare.

Because the sustainable scheme needs to introduce many profit and non-profit organizations to improve sustainability of communities, this article explores that a scheme of innovation improves communication between corporations and stakeholders. Digital industrial revolution features communication scheme between corporations and three types of stakeholders; inside, outside and external stakeholders. Inside stakeholders have constructed firm connections with corporations in the traditional and conventional relations. Outside stakeholders hold relations with corporations in market mechanisms. External stakeholders have not shared any market or social relation with corporations. The sustainable scheme is designed to raise investment of both corporations and stakeholders in communication.

This article supposes that corporations obtain sustainable strategies for global communities with multi stakeholders. Stakeholders correspond to sustainable strategy of corporations. Each stakeholder explores sustainable strategy of corporations to enhance efficiency of communication scheme. According to evaluation of sustainable strategies multi stakeholders are assumed to contribute positively or passively on improving communication scheme of global societies and economies. Efforts to improve communication include innovating methods and investments for digital transformations. This article presents distinctly optimal contribution for three types of stakeholders to improve cooperation of communities. Digital technologies bring corporations to increase communication and information with outside and external stakeholders by using internet services.

This article discusses how digitalization promotes the contribution of outside and external stakeholders in the cooperative scheme. Main results obtained from this investigation are summarized as described hereinafter. First, rising outside stakeholders enhances investment for developing digital communication. Secondly, increasing investment in digital technologies makes corporations raise altruistic coefficient for outside stakeholders. Outside and external stakeholders raise digital communication investments to reduce communication costs with corporations. Thirdly, enlarging scale of outside stakeholders leads mainly to enhance digital communication investments. However, raising total investments obtained by stakeholders brings efficient cooperation of global economies and communities. Fourthly, enlargement of outside stakeholders is the important factor which enhances investments to accelerate digital industrial revolution.

Theoretical Scheme of Sustainability

The preceding research of this article is described as follows. Arrow [6] states that issues of corporate social responsibility (CSR) should be explored by theoretical economic approaches. Tirole [7] develops incentive analysis with one stakeholder by shareholder value evaluating performance of CSR. Researchers in new institutional economics such as Coase [8], Williamson [9,10] advocate that reforms of legislation and institution complement market failures. Tanaka [11,12] provides a theoretical model with multi stakeholders to integrate approaches from legislative and institutional economics and incentive analyses. Tanaka [13] presents a scheme of providing global public goods to share regional welfare losses globally to prevent the financial crises from enlarging to global crises. This investigation implies that social credits are defined by the global public goods which is cooperatively provided with multi stakeholders. Tanaka [14] discusses that green bond finance is related with structural change of stakeholders brought by digital industrial revolution. Tanaka [15] explores those initiatives in sustainable investment influence differently on stakeholders. Social welfare is stated by the total evaluation of stakeholders. Sustainable strategies for investment require reducing social welfare loss.

Global social and economic mechanisms involve various stakeholders. Digital economies have increased stakeholders in international frame works, as Baldwin [16], Szalavetz [17], Yeung [18], Bangkok [19] state.

Tanaka [12] provides a theoretical model for the risk governance of global communities. To proceed theoretical analysis, we introduce the following assumptions for the theoretical investigation. We consider corporation and organization to produce output x for global communities with n stakeholders. When global societies aim to achieve a sustainable provision of some international agricultural products such as wheat and corn, supply and demand mechanisms are constructed by cooperation with many stakeholders. Problems of climate change will aggravate scarcity of food provision for many people who

should be involved in stakeholders of sustainable food provision. Consequently, sustainable governance regarding issues of climate change increase stakeholders by involving many outside and external stakeholders.

The corporation compensates or offers a payment $t_i (\geq 0)$ for any stakeholder i (=1,...,n). The payments are indicated by variables, such as the transaction, contract payments, wages for employees, taxes and fees for governmental agents. The total payment is denoted by $t = \sum_{i=1}^{n} t_i$. The corporation performs activities for profit and takes private net profit $\pi(x)$. According to normal analyses of theories it is assumed that $\pi'(x) > 0$ and $\pi''(x) < 0$ is obtained. The stakeholders are exemplified by employees, shareholders, costumers, banks, corporations of supply chains, residents, and local governments. They obtain various interests with the corporation in many situations. The concern interest between corporation and stakeholder i is exhibited by evaluation of $i; V_i(x, t_i), i = 1, \ldots, n.$ Evaluation function V_i is assumed to increase with t_i for all i. It is defined formally by inequality $\frac{\partial V_i}{\partial t_i} \geq 0$ for $i = 1, \ldots, n.$ To explore the sustainability of communities, stakeholder i (=1,...,n) is classified into positive stakeholder who is defined by $\frac{\partial V_i}{\partial x} \geq 0$ and negative stakeholders who is defined by $\frac{\partial V_i}{\partial x} < 0$, according to relation with the corporation. Positive stakeholders partially share profits with the corporation. But negative stakeholders only reduce evaluation V_i from increasing production of the corporation.

Tanaka [20] assumes that the digital industrial revolution has brought unbalanced development of information industries. To focus on features of the digital revolution stakeholders are divided into three groups: inside, outside and external stakeholders. The inside stakeholders such as regular employees and affiliated organizations obtain common interest with the corporation and are denoted by i (=1,...,n_0). The outside stakeholders represented by irregular employees and occasional customers make more competitive transaction in the markets than inside stakeholders and are written by i (=n_0+1,...,n_1). The external stakeholders are excluded from economic relations with the corporation and suffer sometimes external diseconomies from activities of the corporation and are written by i (=n_1+1,...,n). Many residents in the communities become external stakeholders by economical externality of the corporation. Baecker [21] argues that the digital industrial revolution has brought a serious problem of disruption in the communities. By following the definition in Tanaka [20], inside stakeholders are assumed to be positive stakeholders and outside and external stakeholders are supposed to be negative stakeholders.

Corporations and Sustainable Scheme

Issues of asymmetric information bring many problems in communication between the corporation and stakeholders. Inside stakeholders are supposed to construct highly sensitive communication with the corporation by performing long term transaction or contract. However, outside stakeholders tend to have relations with the corporation by shorter term contract than inside stakeholders. On the other hand, outside stakeholders could be connected more widely and freely with the corporation than inside stakeholders. Outside stakeholder i is willing to provide effort y_i to improve communication with the corporation. By assuming that stakeholder i makes effort y_i on communication, digital industrial revolution takes the corporation to enhance cooperation on communities with innovative spending of information and communication technologies. Because value of information rises as many stakeholders provide information, every stakeholder i raises spending of intelligent technology y_i. Ripkin [22] examies that investment on intelligence and communication is expected to bring network effects in economies and societies. Private provision of public goods is supposed to be applicable for network of intelligence and communication. Bergstrom, Blume and Varian [23], Roberts [24] provide a theoretical foundation of networks.

The total efforts of communication are assumed to provide public goods of intelligence that is denoted by $y = \sum_{i=1}^{n} y_i.$ It is supposed that corporations facilitate network of communication which stakeholders provide. Many articles such as Bernheim [25] and Sugden [26] explore incentives to provide public goods. It is assumed that stakeholders contribute investment for communication on the base of independent own decisions. We obtain mathematical definition $\frac{dy_j}{dx_i} = 0, i \neq j (= 1, \ldots, n).$ The public goods are exemplified by enlargement of communication network. Andreoni [27] features altruistic structure of public goods provision. For outside stakeholders the corporation obtains altruistic coefficient defined by $\gamma(y)$. The network of information means that rising effort y efficiently improves the communication between the corporation and many outside stakeholders. Tanaka [28-31] argues that improvement of digital technologies improves systems of green finance and raises efficiency in cooperative networks, $\gamma(y)$ is supposed to be satisfied with the inequalities, $1 > \gamma(y) > 0, \gamma'(y) > 0$ and $\gamma''(y) < 0.$

However, inside stakeholders do not depend mainly on the digital network of communication but direct and internal communication with the corporation. Inside and external stakeholders are assumed to be a vital member of performance

but to be excluded from communication network developed by outside stakeholders. Corporations share more benefits with inside stakeholders than with outside and external stakeholders. By raising production x corporations need to increase cooperation with inside stakeholders. Altruistic coefficient between the corporation and inside stakeholders $\beta(x)$ is assumed to increase with production of the corporation after corporation Oskam [32] provides an example of sharing economies. This assumption implies that cooperations with inside stakeholders are required to enlarge production and is written mathematically by $\beta'(x) > 0$ and $\beta''(x) < 0$. It is assumed that the corporations take closer connection with inside stakeholders than outside stakeholders. In mathematical expression, the inequality $\beta(x) > \gamma(y)$ is obtained for any x, y.

Tanaka [33] argues that digital industrial revolution is expected to reduce social welfare losses. However, some initiatives should be mixed to achieve sustainable communities. Tanaka [20] explores that incentive initiatives to embody legislative schemes are effective to improve sustainable social scheme. Incentive schemes constructed by legislations, regulations, standards, and others efficiently improve the sustainability of communities . Stakeholder i requires for corporations to target parameter α_i. after communities Pistor [34] argues that law improves welth and inequality. Corporations are obliged to pay social costs based on evaluation gap from α_1. Inside or outside stakeholder i is assumed to use α_i as an index of transactions or bargains with the corporation. However, external stakeholders are influenced by activities of corporations and are involved in the legislative mechanisms. Legislations or social contracts take α_i as an evaluation of legislated target or voluntary standard of stakeholder i. Incentive initiatives aim to reduce the gap $\alpha_i - V_i(x, t_i)$ for each i by using the legislations. Incentive schemes enforce the corporation to integrate the evaluation of external stakeholders into social corporate governance.

To simplify analysis the targeted value α_1 is assumed to be greater value than the evaluated value $V_i(x, t_i)$. This assumption is written by inequality mathematically, $\alpha_i \geq V_i(x, t_i)$. As the gap between target α_i and the evaluated value $V_i(x, t_i)$ increases i should bear greater punishment, such as taxes and costs brought by rising requirements. The punishment function $\phi_i(\alpha_i - V_i(x, t_i))$ is assumed to be an increasing cost curve regarding $\alpha_i - V_i(x, t_i)$. This function obtains the same relation as the cost function is stated by $\phi_i' > 0, \phi_i'' > 0$. The feature of cost function illustrates implication of incentive scheme as follows. Climate change problems require to enhance α_i regulation of CO_2 emission. And construction of facilities to provide fresh water with high quality for agriculture

needs to raise target or standard α_i forthe relating stakeholder i. Tanaka and Tanaka [32] demonstrates that ESG schemes to raise standard α_i enhance sustainable investments.

Digital Innovation and Contribution of Stakeholders

Sustainable social mechanisms integrate evaluations of all stakeholders by using legislative schemes. Digital industrial revolution is expected to bring a large scale of reform of social and economic systems. Corporations develop cooperative scheme among stakeholders according to improving digital technologies. The following Equation (1) revises social net benefits of the corporation presented by Tanaka and Tanaka [35] to explore influences of innovation of digital technologies. It is assumed in this section that mechanism of sustainable governance integrating stakeholders is explored by using object function (1). Corporations take incomplete evaluation on own performance by inside and outside stakeholders. Although corporations cannot obtain accurate evaluation of external stakeholders based on actual economic and social activities, incentive scheme for sustainable communities is constructed to reduce problems of asymmetric information between corporations and stakeholders. As external stakeholders form a part of information communication, the Equation (1) adds effort of external stakeholders in the fourth term in the right side to the previous research. Corporations are not assumed to evaluate external stakeholders exactly, but investment of all stakeholders significantly enhances influences of communication. Rising outside stakeholders enforce stakeholders' connections with corporations for all types of stakeholders. Incentive scheme for sustainability presented the last term in the right side of Equation (1) exhibits evaluation of external stakeholders.

$$NB = \pi(x) + \beta(x)\sum_{i=1}^{n_0}\{V_i(x,t_i) - y_i\} + \gamma(y)\sum_{i=n_0+1}^{n_1}\{V_i(x,t_i) - y_i\} - \gamma(y)\sum_{i=n_1+1}^{n_0} y_i - t - \sum_{i=1}^{n}\phi_i\{\alpha_i - V_i(x,t_i)\} \quad (1)$$

The corporations are assumed to perform an analysis of cost benefits based on Equation (1). Corporations contribute innovation in digital technologies to improve the system of economies and societies. Although y does not include any contribution of corporations, investment by stakeholders is assumed to raise the net profits of corporations. Consequently, investment for digital innovation induces corporations to improve communication with stakeholder i by spending t_i. This article demonstrates that innovation of communication scheme brought by rising y improves sharing system of public investments.

Development of digital technologies and infrastructure of communication are voluntarily provided by stakeholders.

Corporations are assumed to use the global information and communications as global public goods. Stakeholders need to spend cost of information y_i to obtain efficient communication with the corporations. However, corporations and some stakeholders possibly share benefits or burden costs from enhancing efficiency in communication mechanism. Inside and outside stakeholder i influence performance of corporations by exhibiting information, $V_i(x, t_i)$. Outside and external stakeholders are available for a fundamental structure of communication in digital societies indicated by efficient coefficient $\gamma(y)$. Corporations are assumed to pay $\gamma(y) \sum_{i=n_0+1}^{n} y_i$ for the contribution of external stakeholders on the digital structure.

However, inside stakeholders have access to a better communication environment with corporations indicated by parameter $\beta(x)$. Equation (1) presents that corporations owe $\gamma(y)$ rate of communication cost of external stakeholders in digital scheme. Construction of digital economies and societies requires participation of many stakeholders with large amounts of investments. From a different perspective, y_i indicates investment by stakeholder i to improve digital technologies. Tanaka [20] assumes that external stakeholders contribute improvement of communication technologies, but that corporations cannot evaluate the costs of efforts to improve communications and information. However, this article assumes that innovation of digital further evolves. Corporations become possible to recognize the contribution by the external stakeholders. External stakeholders indirectly present their interests by information media such as SNS: social networking services. If corporations evaluate positively investment to enhance communication with analyses of cost benefits, external stakeholders are supposed to invest improvement of communication.

Effort of stakeholders for digital investment collects together to promote further development of digital economies and societies. The theoretical exploration as following description. Differentiating Equation (1) with y_i presents that stakeholders obtain different strategies for investment of digital technologies. Equation (2) exhibits optimal condition to improve communication investment by inside stakeholders. The right side of Equation (2) indicates marginal net benefit of using digital services and is supposed to be decreasing. This condition indicates an equilibrium investment effort to use closed and open information networks.

$$\beta(x) = \gamma'(y^I)\{-y^I + \sum_{i=n_0+1}^{n_1} V_i(x, t_i)\}, \quad i = 1, \ldots, n_0. \quad (2)$$

The above Equation (2) explores how inside stakeholders spend investment of communication. While inside stakeholders improve technologies of communication, the innovation enhances communication environment for outside stakeholders. Equation

(3) writes the optimal investment for outside and external stakeholders to communicate with corporations. The right sides of expression (2) and (3) are proved to be downward sloping by considering $\gamma'(y^I) > 0, \gamma''(y^I) < 0$ and

$$\gamma''(y)\{-y + \sum_{i=n_0+1}^{n_1} V_i(x, t_i)\} - \gamma'(y) < 0.$$

The outside and external stakeholders invest in communication systems so that index of $\gamma(y)$ may be equal to marginal benefit by enhancing digital platform.

$$\gamma(y^o) = \gamma'(y^o)\{-y^o + \sum_{i=n_0+1}^{n_1} V_i(x, t_i)\}, \qquad i = n_0 + 1, \ldots, n. \quad (3)$$

By comparing expressions (2) and (3) $\beta(x) > \gamma(y)$ brings inequality $y^o > y^I$. It means that outside and external stakeholders would like to provide more investment for communication than inside stakeholders. Consequently, involvement of outside and external stakeholders is expected to raise sustainable investment on global communities. When we use the following notations

$$y^I = \sum_{i=1}^{n_0} y_i^I, \quad y^o = y^I + \sum_{i=n_0+1}^{n} y_i^o,$$

the contribution of outside stakeholders is expressed by $\sum_{i=n_0+1}^{n} y_i^o > 0$.

Outside and external stakeholders provide investment to improve communication environment. Although total investment of outside and external stakeholders is necessary to enhance digital technologies, this article does not argue that all stakeholders should not contribute investment of communication. It is possible that some stakeholders i may not contribute investment, $y_i^o = 0$.

Expression (3) is transformed into Equation (4). As total net benefit of outside stakeholders increases, the right side of expression (4) means decreasing growth rate of $\gamma(y)$.

$$\frac{\gamma'(y)}{\gamma(y)} = \frac{1}{-y \sum_{i=n_0+1}^{n_1} V_i(x, t_i)}, \qquad i = n_0 + 1, \ldots, n. \quad (4)$$

Investments to Improve Digital Environment

This section explores how cooperation of multi stakeholder improves sustainability of global communities. Equation (2) and (3) exhibit voluntary scheme to share the construction of communications by using illustration of Figure 1. The right sides of (2) and (3) are depicted by a downward sloping curve AB. y^I and y^o are expressed by intersection points of AB and $\beta(x)H$, AB and $\gamma(x)L$. y^I and y^o illustratively indicates cooperative provision of investment to improve communication. Positive values to present y^I and y^o imply that improvement of digital technologies need a contribution of every stakeholder. However, curve AB indicates that inside stakeholders are willing to provide investment y^I and that outside and external stakeholders are willing to provide investment y^o. Inequality $y^I < y^o$ implies that outside and external

stakeholders extend sustainable investment. It demonstrates that digital industrial revolution expands sustainable investment. Rising altruistic coefficients enhance $\beta(x)H$. This shift moves intersection points C and D upwardly. Enhancing efficiency of communication can reduce investment for communication y^I and y^o. The assumption $\gamma'(y) > 0$ means that horizontal line $\gamma(x)L$

locates upwardly to curve $\gamma(x)K$. Improvement in communication environment indicated by rising $\gamma(x)$. It is illustrated to raise intersection point F to point D. Investment by outside and external stakeholders increases the amount expressed by distance EF. Consequently, contributions of two stakeholders raise efficiency of communications.
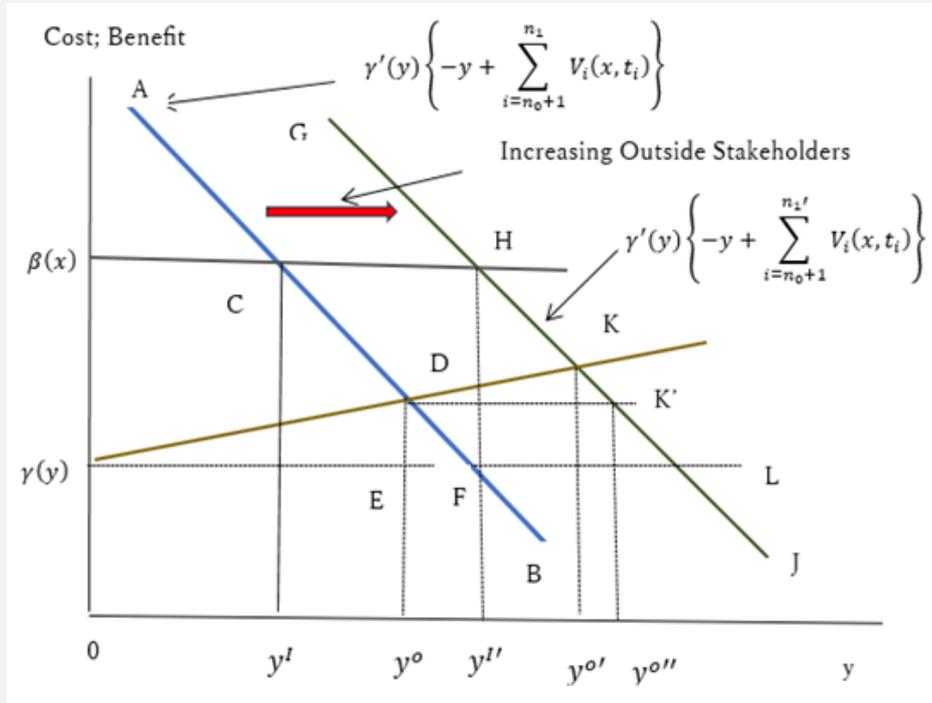

Figure 1: Contribution to digital investment and stakeholders.

Source: Produced by the author.

Tanaka [20] discusses that digital industrial revolution brings increase of outside and external stakeholders. Figure 1 shows that enlarging outside stakeholders change the share of stakeholders in sustainable investment. When outside stakeholders raise scale n_1 to n_1', curve AB moves to curve GJ. Inside stakeholders are willing to raise investment by $y^{I'} - y^I$. As curves AB and GJ are supposed to be parallel, $y^{I'} - y^I$ presents same distance $y^{o'} - y^o$. Because inside stakeholders aim to increase investment by $y^{I'} - y^o$, outside and external stakeholders are obliged to provide investment of $y^{o'} - y^{I'}$. Inside stakeholders increase sustainable investment with inside and external stakeholders. As communication between corporations and stakeholders improves, DK′ rotates into DK by angle $y'(y)$. The optimal investment $y^{o'}$ is obtained with smaller efforts than status quo $y^{o''}$ by $y^{o''} - y^{o'}$.

Concluding Remarks

This article assumes that corporations perform sustainable governance with multi stakeholders to achieve cooperative communities. Stakeholders as well as corporations are required to enhance sustainability of communities. Tanaka and Tanaka [32] explain theoretically that ESG (Environment Society and Governance) investment strategies of sustainability improve social welfare. Sustainable scheme presented by Equation (1) indicates that corporations are guided to estimate net social welfare. When every stakeholder promotes digital innovation to maximize net social welfare, sustainable scheme brings eventually cooperative investment for communication. Tanaka [36] explores that digital industrial revolution changes income distribution among stakeholders. Tanaka and Tanaka [37] demonstrate that rising

outside stakeholders in green bond issuance bring sustainable communities. In sustainable scheme the optimal solution can induce cooperative investment of multi stakeholders.

Theoretical results herein demonstrate that cooperative provision of investments for communications requires differentiated contributions of multi stakeholders. Incidentally, the digital industrial revolution has changed the structure of stakeholders. At first, distinguished developments in outside stakeholders have appeared. As social structure of communication improves, inside and external stakeholders become to obtain efficiently information of corporations. Corporations and multi stakeholders can transact larger amounts of information in a short period of time than before. Sustainable scheme of corporative governance requires cooperation of multi stakeholders. Cooperative scheme of governance promotes greatly sustainable investments with inside stakeholders as well as outside and external stakeholders. By way of the digital industrial revolution sustainable scheme of a community reforms contribution of stakeholders for sustainable investments of communication and intelligence.

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